· ENGINEERING NEWS-RECORD ·
SEPTEMBER 8, 1938

THE WEEK'S EVENTS

Biggest Generators Put Under Contract

Westinghouse will build three 108,000-kw. units for Grand Coulee Dam power plant

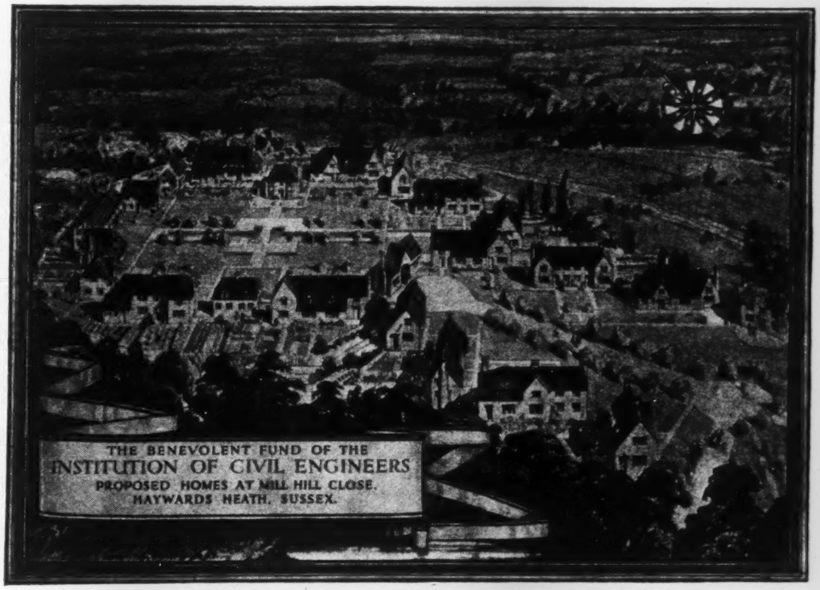
Contract for manufacture and installation of three 108,000-kw. generators, largest in the world, for the Grand Coulee power plant has been awarded to Westinghouse Electric & Mfg. Co. of Denver on its bid of $2,611,000. The three generators will make up the initial installation, except for station service units, at Grand Coulee Dam on the Columbia River.

Eventually there will be two power houses at Grand Coulee, one at each end of the dam. The existing contract for construction of the dam to its full height provides for completion of the left power house and for construction of the foundation of the right power house. The left power house will ultimately contain nine main generating units, each with a capacity of 108,000 kw., and three station service units of 12,500 kw. each. Six of the main units will furnish power to operate irrigation pumps located upstream from the dam.

Bigger than Boulder

The generators at Grand Coulee are nearly a third larger than the 82,500-kw. generators at Boulder Dam and are about two and a half times the size of any other existing generators. The Grand Coulee generators will produce three-phase 60-cycle current at 13,800 volts. They are of the vertical-shaft type operating at 120 r.p.m.

The contractor is given 1,050 calendar days to complete and install the first generator, 1,140 for the second, and 1,230 for the third.


THE BENEVOLENT FUND OF THE
INSTITUTION OF CIVIL ENGINEERS
PROPOSED HOMES AT MILL HILL CLOSE,
HAYWARDS HEATH, SUSSEX.

HOMES FOR POVERTY-STRICKEN ENGINEERS

An unusual project was initiated by the Benevolent Fund of the Institution of Civil Engineers, London, when it appealed last July for contributions towards a scheme for providing homes for beneficiaries of the fund. A 5-acre tract has been obtained on which it is planned to erect 38 houses at a total cost of $175,000. It is intended to provide homes for the beneficiaries of the benevolent fund "more in keeping with the standards of living to which they have been accustomed."

The Benevolent Fund of the Institution of Civil Engineers was organized in 1864. Supported by means of gifts, bequests, and annual subscriptions, the fund affords assistance to necessitous persons who are members or former members of the Institution of Civil Engineers, as well as to the families of deceased members.

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Underground Water Bill Planned in Texas

A bill to effect the conservation of underground water supplies has been prepared by a special committee of the Texas legislature and will be submitted to the legislature at its next session. The proposed bill would subject to regulation all underground water except that used for household purposes, watering of livestock, and watering of gardens for individual use.

All water used for industrial, irrigation or municipal supplies would be classified as public, and users of public water would be required to obtain permits from the State Board of Water Engineers.

The board would have authority to deny permits, and, according to the committee drawing up the bill, it is contemplated that permits would be refused when necessary to prevent lowering of the water table. The committee states that the underground water supply has been depleted in several sections of Texas, particularly in the winter garden area and the Gulf Coast section near Houston.

Quebec Flood Waters Cause Much Damage

Train is wrecked in bridge washout and tenement destroyed in landside

Two months of unusually heavy rainfall near the city of Quebec was climaxed on the night of Aug. 31 by an exceptionally heavy rainstorm which resulted in the loss of eleven lives, the wreck of a Canadian Pacific train and nearly a million dollars damage to roads and bridges in the province.

Forty miles west of Quebec, a Canadian Pacific train crashed through a bridge over the Portneuf River, when the structure, its abutments weakened by rising floodwaters, gave way under the weight of the locomotive. The engine, tender, and two cars, fell into a 50-ft. gully, and one of the four passenger coaches left the rails. Two of the train crew were killed and about twenty passengers injured. Later in the day two more railway bridges in this district were destroyed by the flood, badly disrupting train service.

The same night, a portion of the cliff overhanging the town of St. Gregorie de Montmorency, a few miles east of Quebec, gave way under the heavy rainfall, demolishing a four-story tenement house of brick and timber construction in which about 60 people were sleeping. Four of the tenants were killed and a number of others were injured. Prompt action by a construction crew working on the Isle of Orleans bridge in extricating the survivors from the ruins prevented more numerous fatalities.

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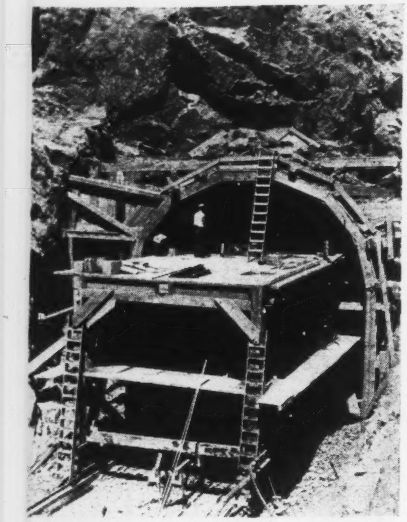
Employment on WPA Reaches New High

The number of men employed on WPA projects reached an all-time peak of 3,039,000 for the week ending Aug. 20, PWA Administrator Harry L. Hopkins has announced. The previous peak of about 3,036,000 was reached in February, 1936. Thereafter WPA employment declined to a low of 1,448,000 in early October, 1937. The Aug. 20 figure was an increase of 22,000 over the preceding week.

"Although the rate of increase in unemployment," Hopkins said, "has slackened during recent months, large numbers of workers who lost their jobs, during the winter and spring months are being forced to seek public assistance for the first time. . . .

"In relation to the volume of unemployment, the number on WPA is actually lower than it was in 1936. . . ."



BYPASS TUNNEL AT SHASTA

CONSTRUCTION of the bypass tunnel through the site of Shasta Dam, major item in the Central Valley project, got under way in earnest as Colonial Construction Co., the contractor, brought its drill rig to the portal heading.

The tunnel, drilled through the abutments at Shasta Dam, will carry railroad traffic which now goes through the site of the dam until the permanent relocation above reservoir level is completed. After trains stop using it, the tunnel will be utilized as a diversion tunnel.

Tacoma Bridge Bids Are Postponed

The Washington State Toll Bridge Authority has postponed opening of bids for construction of its $5,400,000 suspension bridge across The Narrows near Tacoma from the original date of Sept. 2 to Sept. 27. L. V. Murrow, state highway director, said he "was convinced no bidders have had enough time to figure the job." An alternate design, Murrow said, is being prepared for the main piers of the bridge and will be sent out to contractors by Sept. 10.

Contractors may bid on any or all of the six units—construction of two land piers, center pier, approaches, towers, steel deck and cables.

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Traffic Staff Chosen On Nationwide Basis

Use of civil service examinations open to the country at large were responsible for filling some of the top positions in the newly created Detroit city traffic engineering bureau with out-of-town engineers. Harry C. Koch, who was chosen associate traffic engineer, is from Detroit. Parley F. Wiley, assistant traffic engineer, is from Springfield, Ill., and W. P. Wilson, assistant traffic engineer, is from Ann Arbor, Mich.

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Mississippi County Seeks Repayment for Paving

The board of supervisors of Madison County, Miss., has brought suit in chancery court against the Mississippi highway commission in an effort to recover the cost incurred by the county in paving certain highways which were later taken into the state highway system. Under present state law, the highway department is obligated to repay counties for paving done on state routes if and when the payment can be made. No county, however, has so far been reimbursed for paving.

Madison County is seeking $166,000. The county contends that it paved the highways with the understanding that the highway department would take them over and pay for construction.

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Roza Dam Contract Let to Boise Firm

Contract for construction of the Roza diversion dam, major engineering structure of the Roza division of the Yakima federal reclamation project, was awarded Aug. 29 to the Morrison-Knudsen Co. of Boise, Idaho on its low bid of $527,000. The contract also covers construction of 1,600 ft. of 28-ft. wide bench flume at the head of the Yakima Ridge Canal and a railroad bridge for the Northern Pacific crossing near the head of the canal.

The Roza dam will divert water from the Yakima River into the Yakima Ridge Canal which will irrigate 72,000 acres of undeveloped land in the Roza division. The dam will be a concrete structure about 55 ft. high with an overflow section on either side of the center pier.

Construction of the Yakima Ridge Canal is now well advanced.

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Malcolm to Teach At Cornell

W. Lindsay Malcolm, professor of municipal engineering at Queens University, Kingston, Canada, has been appointed director of the school of civil engineering of Cornell University. Malcolm graduated from Queens in 1905 and was city engineer of Stratford, Ontario and associate city engineer of Guelph, Ontario, until 1907, when he joined the staff at Queens. Except for war service, he has been on the Queens faculty ever since.

Identical Cement Bids Received Twice

Identical bids to supply cement for construction of the Tom Miller dam were received for the second time early in September by the Colorado River Authority. On a second bid call, after identical bids from the same companies were rejected in mid-August by the authority, five companies each offered to furnish 105,000 barrels of cement at $2.19 and 54,000 sacks at 66 cents each.

The companies bidding were Longhorn, Oakland, Lone Star, Universal Atlas, and Trinity. The authority will consider the new bids at its next meeting Sept. 19.

CONTRACTS AND CAPITAL

Engineering construction awards for the short week due to the Labor Day holiday total $52,456,000, a gain of 42 per cent over the corresponding week last year.

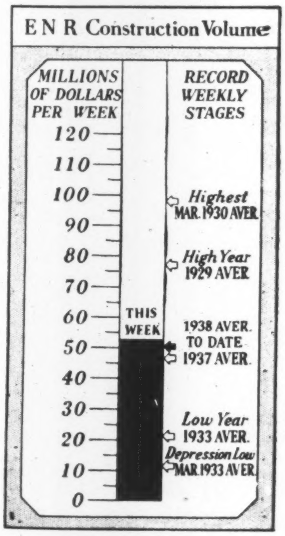
This week's total brings the volume for 1938 to date to $1,819,210,000, an increase of 3.7 per cent above the $1,753,990,000 for the 36-week period in 1937.

Private awards are 4 per cent above the 1937 week, due to the high volume of commercial building and large-scale housing. Public construction is 71 per cent above last year. The large number of highway, public building and sewerage projects getting under way is responsible for the public gain.

Five large apartment and residential development projects in or near New York City totalling $9,400,000, and three additional large projects, one each in Massachusetts, Virginia, and California, are responsible for the commercial building and large-scale housing gain over a year ago. Sewerage, earthwork and drainage, and commercial building and large-scale housing are higher than a week ago.

New construction capital for the week totals $45,523,000. It is made up of $15,145,000 in PWA allotments for non-federal projects, $14,816,000 in state and municipal bonds, $13,648,000 in corporate security issues, and $1,914,000 in REA loans to co-operative associations in 19 states.

New financing for 36 weeks of 1938, $2,828,044,000, is 74 per cent higher than the $1,625,414,000 for the corresponding period a year ago.



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CONTRACTS

(Thousands of dollars)

	Week Ending Sept. 9 1937	 Sept. 1 1938	 Sept. 8 1938
Federal	$2,982	$8,686	$7,001
State & Municipal	18,140	34,372	29,011
Total public	$21,122	$43,058	$36,012
Total private	15,746	9,161	16,444
TOTALS	$36,868	$52,219	$52,456

Cumulative

1938 .... (36 weeks) $1,819,210

1937 .... (36 weeks) $1,753,990

Note: Minimum size projects included are: Waterworks and waterways projects, $15,000; other public works, $25,000; industrial buildings, $40,000; other buildings, $150,000.

NEW PRODUCTIVE CAPITAL

	Cumulative 1937 36 Wk.	 1938 36 Wk.
NON-FEDERAL	$1,209,289	$1,684,102
Corporate securities	439,490	284,863
State & Mun. bonds	383,041	407,089
PWA loans, grants	156,819	525,688
RFC loans	29,939	96,891
U.S.H.A. loans	....	154,528
R.E.A. loans	....	13,543
Federal Aid-Highways	200,000	201,500
FEDERAL	$416,125	$1,143,942
TOTAL CAPITAL	$1,625,414	$2,828,044

FHA MORTGAGES

	Cumulative 1937 35 Wk.	 1938 35 Wk.
Mortg. selected for appraisal	$440,971	$658,422

ENR INDEX NUMBERS

Index Base		1913	1926
Construction Cost	Sept.	232.70	111.86
Building Cost	Sept.	194.80	105.30
Volume	Aug	218	96

State Not To Compete With Toll Bridges

Court enjoins Arkansas highway department from operating free ferries near toll bridges

The Arkansas highway department has been permanently enjoined by federal district court from operating free ferries across the White and Black rivers in competition with toll bridges owned by the White and Black Rivers Bridge Co. The bridge company brought suit in federal court because it is in receivership.

The court's decision, handed down Sept. 2, held ". . . that the operation . . . of a ferry . . . would constitute an infringement of the contract rights and franchise rights held by" the bridge company. The department was further enjoined from erecting signs directing traffic away from the bridges and to the free ferries.

Tried to buy bridges

The present situation is an aftermath of the appropriation last March by the state legislature of $120,000 to enable the state to acquire and make toll-free the two bridges. When the bridge company refused this offer as insufficient, the highway department began operation of the free ferries and put up signs along the highway directing traffic to the ferries.

The present injunction will have no immediate effect on the situation, because the court has permitted the highway department to appeal to the Circuit Court of Appeals and is maintaining the status quo pending the outcome of the appeal. Governor Bailey of Arkansas stated that the case would be appealed to the U. S. Supreme Court if necessary.

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Oklahoma Deficit Forces Halt in Road Work

The Oklahoma highway commission announced Aug. 31 that it will start no new highway construction before Jan. 1. This action is taken in an effort to prevent increasing a $4,300,000 departmental deficit. No highway contract lettings will be held until November and then only on work not to start until the first of the year. Part of the state's present day labor work is being dropped.

The financial difficulties of the department arose, according to the highway commission, because contracts on the 1938 federal-aid program were let too fast. Most of the 1938 program, it is stated, is already under contract.

BRIEF NEWS

The Passaic Valley Sewerage Commission has requested the Interstate Sanitation Commission to deny a request by New York City that the waters of upper New York Bay be placed in the A classification, which would require that they be kept in a state of purity suitable for recreational and shell fish uses. The area proposed for reclassification by New York City would include the Passaic Valley outfall line from which treated sewage is discharged.

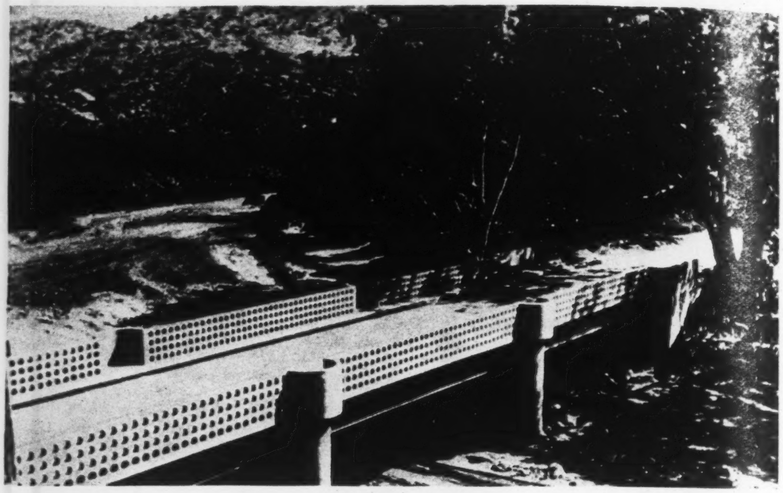
The Federal Power Commission on Sept. 3 announced that it had ordered the Pennsylvania Water & Power Co. to show cause why proceedings should not be instituted against the company for operating the Holtwood power development on the Susquehanna River without a license from the commission. The Holtwood development, of 150,000 hp. capacity, is located between the Conowingo and Safe Harbor plants, both licensed.

Autumn review courses in engineering subjects are being offered by the Metropolitan Section of the American Society of Mechanical Engineers and the New York Section of the American Institute of Electrical Engineers, jointly, at fees ranging from $10 to $20. Subjects include structural planning and design, engineering economics, basic engineering sciences, public speaking, and law for engineers. Courses start about Sept. 12 in the Engineering Societies building.

The Niagara River at Buffalo is rapidly regaining its freshness now that its former pollution is cleared up by the new Bird Island treatment plant at Buffalo. Observers at pumping stations along the river report that the bacteria count has dropped from an average of 40,000 per c.c. to 3,000.

Although New York state has paid out more than $66,000,000 in unemployment insurance benefits since the first of the year, its balance in the unemployment trust fund is greater by more than $10,000,000 than it was Jan. 29 when the first benefit check was written. On Aug. 31, New York state's balance stood at $114,805,000.

Construction of hotels is to be encouraged by the Mexican government through the Credito Hotelero, a public corporation with a capital of about $3,600,000. The Credito will make loans to private interests for building or reconditioning hotels. It will exercise supervision over plans and number of hotels. Loans will carry 10 per cent annual interest and be repaid in five to ten years.



NEW BRIDGE IN ETHIOPIA

Crossing the Balua River, this reinforced concrete bridge is one of the 128 larger bridges built as part of the Italian road-building program in Ethiopia. The perforated railings of the bridge are to permit passage of flood water.

During the 13 months ending July 30. a total of 2,028 miles of highway was built in Ethiopia. Asphalt surfacing has been put on 1,180 miles

Largest single project is the Addis Ababa-Asmara road, 688 miles long. On this one road, 1,864 bridges were built. The total cost of the highway was about $41,300,000.

CALENDAR OF MEETINGS

NATIONAL SOCIETIES

American Public Works Association, annual meeting, New York City, Oct. 3-5.

National Safety Council, annual congress, Stevens Hotel, Chicago, Oct. 10-14.

American Institute of Steel Construction, annual convention, French Lick Springs, Ind., Oct. 10-14.

Montana National Bituminous Congress, Edgewater Gulf Hotel, Biloxi, Miss., Oct. 10-13.

National Reclamation Association, annual meeting, Reno, Nev., Oct. 11-13.

American Society of Civil Engineers, fall meeting, Rochester, N. Y., Oct. 12-14.

American Welding Society annual meeting, Book-Cadillac Hotel, Detroit, October 16-21.

National Council of State Boards of Engineering Examiners, annual convention, Hotel Fort Des Moines, Des Moines, Iowa, Oct. 17-19.

National Society of Professional Engineers, annual meeting, Pittsburgh, October 17-19.

American Railway Bridge and Building Association, annual meeting, Hotel Stevens, Chicago, October 18-20.

Canadian Institute of Sewage and Sanitation, annual convention, Royal York Hotel, Toronto, October 20-21.

American Public Health Association, annual meeting, Kansas City, October 25-28.

LOCAL AND REGIONAL

American Water Works Association, local section meetings scheduled:
Rocky Mountain, Casper, Sept. 12-13.
New York, Poughkeepsie, Sept. 22-23.
Wisconsin, in Milwaukee, Oct. 10-12.
Four States, Washington, Oct. 6-7.
South West, Oklahoma City, Oct. 17-20.
New Jersey, Asbury Park, Oct. 21-22.

Western Safety Conference, annual meeting, Los Angeles, Sept. 12-15.

New England Water Works Association, annual convention, Hotel Statler, Boston, Sept. 13-16.

Rocky Mountain Sewage Works Association, annual meeting, Casper, Wyo., Sept. 14.

New England Sewage Works Association, and New York Sewage Works Association, joint meeting, Hotel Bond, Hartford, Oct. 6-8.

Michigan Association of Road Commissioners and Engineers, Michigan State College, East Lansing, Oct. 25-27.

LABOR NOTES

A SEVEN WEEKS strike of building workers on city projects in St. Louis (*ENR*, July 21, 1938, p. 70) ended Sept. 1 without having obtained its objective. The strike was called mainly in sympathy with a strike of city-employed hoisting engineers, but demands were also presented by carpenters, laborers, and plumbers. The hoisting engineers, demanding a wage increase of 25 cents an hour, are still out.

ANOTHER St. Louis strike terminated at the month's end when A.F.L. electricians signed an agreement with the Electrical Contractors Association. The association had raised no objection to a wage increase for Class B workmen from $1.10 to $1.50 an hour, but the union was unwilling to sign with the association, desiring to sign with contractors individually, the union asserting that three members of the association had been guilty of "unethical practices." The contract was signed after charges against two of the contractors had been straightened out and it had been agreed to submit the complaint against the third member of the association to the international president of the Brotherhood of Electrical Workers.

CARPENTERS in the Pittsburgh area went on strike Aug. 26 against 64 lumber companies affiliated with the Lumber Institute of Allegheny County. They sought a wage increase from 90 cents to $1 an hour.

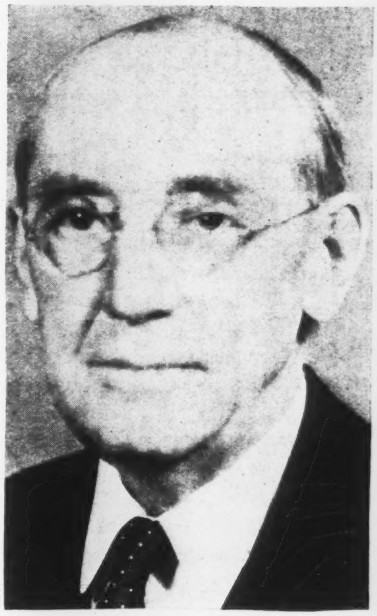
FIRST WORK on the Wappapello Dam near Wappapello, Mo., was halted when a common laborers union picketed land-clearing operations at the dam demanding that the basic wage be increased from 30 to 50 cents an hour.

PAINTERS in Brooklyn, N. Y., members of District Council 18 of the Brotherhood of Painters, Decorators, and Paperhangers, A.F.L., are on strike as the result of the refusal by Associated Painting Employers of Brooklyn to renew the existing agreement. The employers association seeks a reduction of the present $11.20 pay for a 7-hour day to $10.50.

IN MANHATTAN, however, the painters agreement was renewed at the previously existing Manhattan scale of $10.50. The new agreement includes a ban on the use of spray guns.

LEGISLATION requiring contractors to furnish pure drinking water and sanitary paper cups to workmen on construction projects will be sponsored at the next session of the New York State legislature by the New York State Federation of Labor, president George Meany has announced. The federation has taken this action at the request of the building trades unions.

THE WAGE RATE for common labor on clearing operations at the Quabbin Dam of the Boston water supply project has been set at 62½ cents an hour by Commissioner of Labor J. T. Moriarty. Overruling protests that this rate would disrupt the 50-cent scale said to be prevailing in this area, Moriarty pointed out that an act passed by the recent session of the legislature provided that a minimum scale of $5 per day be paid.



THIRTY YEARS IN ST. LOUIS

EDWARD E. WALL, director of public utilities of St. Louis, on Aug. 16 marked the 50th anniversary of his first job with the city. On two occasions, totalling ten years, Wall left the city service for private practice, but the remaining 40 years have been spent entirely with the city. At 78, he still maintains regular office hours.

In 1904, Wall utilized the then little-known lime and iron process to coagulate the muddy water of the Mississippi, providing clear water to greet visitors to the St. Louis World's Fair. In two years, typhoid dropped from 48 to 20 deaths per 100,000.

St. Louis newspapers allotted considerable space to Mr. Wall in connection with his anniversary, including a couple of appreciative editorials.

Hosler of Buckeye Dies at Findlay

Edward Capouch dies after thirty-nine years service with American Bridge

W. F. Hosler, chairman of the board of directors and former president of The Buckeye Traction Ditcher Co. of Findlay, Ohio, died in Findlay Aug. 20 at the age of 78.

EDWARD CAPOUCH, contracting manager of the American Bridge Co. of Chicago, died Aug. 28 at the age of 62. Capouch had been with American Bridge since 1899. He entered the contracting department in 1901 and was made contracting manager six years later.

WILLIAM B. PRICE 70, secretary-treasurer of the Price Construction Co. of Baltimore since 1912, died there Sept. 3.

SPENCER H. CROOKES, 70, Seattle civil engineer, died there Sept. 1.

JOHN R. COLWELL, contractor of Seattle, died there Aug. 27 at the age of 72.

HUGH J. BAKER, 55, Indianapolis structural steel fabricator and contractor, died there recently. Baker graduated from Ohio State University in 1905 as a civil engineer and worked for two years with the American Bridge Co. After some years with Brown Ketcham Iron Works, he started his own business.

GEORGE R. STEARNS, Philadelphia architect who retired from active practice in 1932 and formerly director of public works of Philadelphia, died there Aug. 30 at the ago of 70. Stearns graduated from the University of Pennsylvania in 1887 and then studied engineering at the Drexel Institute of Technology. He held his position with the city during the years 1907–1911.

THOMAS J. MCCORMICK, a retired civil engineer formerly a member of the Detroit construction firm of Schailer & McCormick, died in Detroit Aug. 24 at the age of 68.

STUART A. STEPHENSON, professor of mathematics and engineering at Rutgers University, died in New Brunswick, N.J. Sept. 1, at the age of 60. Stephenson joined the Rutgers staff in 1910, becoming professor of research engineering in 1934.

FRANK ELENANE, formerly assistant PWA administrator for Massachusetts, died at Boston Sept. 1 at the age of 55. Before becoming assistant administrator in 1934, Elenane was assistant PWA engineer for the state.

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Editor, F. E. SCHMITT • *Editorial Staff,* V. T. BOUGHTON
C. S. HILL, N. A. BOWERS, W. G. BOWMAN, E. J. CLEARY
W. W. DE BERARD, H. W. RICHARDSON, R. B. COLBORN

Editorial Offices at 330 West 42nd Street, New York
SEPTEMBER 8, 1938

A NEW RIGHT-OF-WAY PROBLEM faces state highway departments as express highway planning looms up among future road activities. In past days, right-of-way acquisition consisted largely of clipping corners and negotiating for narrow ribbons of land outside the old fence lines. To provide 200 and 300-ft. widths for express roads is a different task, as has been found out in building Maryland's Governor Nice Highway, Massachusetts' new turnpikes and Michigan's superhighways in Wayne County. The express highway introduces a new order of right-of-way transactions; an order in which in land acquisition presents an almost unexplored field of ownership interests, local development aspirations and political ambitions. In many cases these constitute resistances that transcend the power of the right-of-way organizations and control methods adequate for the less exacting requirements of ordinary main road improvement. It was almost solely because of failure to realize the size of the problem and to set guards and checks against false results in securing right-of-way for the Merritt Parkway that the Connecticut highway department was recently put under indictment of neglect and carelessness and its record of a generation of good work besmirched. The express highway, even in its present rudimentary development, carries the lesson that old methods of right-of-way acquisition are not sufficient.

Laboratory Philosophy

WHEN THE New England Water Works Association holds its annual meeting in Boston next week it will appropriately be close to one of the great workshops of sanitary engineering, the laboratories of Harvard University. Members of the profession have profited greatly from it, either directly through training received or indirectly through application of its research findings. It is of special interest, therefore, to publish in this issue (page 297) an article on the equipment and philosophy applied to the training of men and the solution of problems in sanitary science. Prof. Gordon Fair and his colleague, Prof. Moore, in outlining what they consider to be essential, find that simple, small-scale equipment when used with intelligent appreciation of fundamental principles is productive of the best results in laboratory research. That this philosophy is sound is proven by accomplishments at Harvard.

Service With a Smile

EFFICIENCY in water service includes more than technical excellence in plant and personnel. It calls into play good business management as well as sound public relations. How the observance of this trio of fundamentals has given high distinction to one water company is the theme of the Indianapolis story on page 302. In this detailed account of operating a water supply business as a private enterprise there are many worthwhile pointers for the men who are operating public water systems. It should be noted that, quite aside from the technical aspects of providing reliable service, special emphasis is placed on maintaining harmonious relations with the public. This involves, first, prompt and courteous attention to complaints, and includes careful billing practice, equitable rates, education of the public to an appreciation of what they are getting, and a host of other details, all designed to keep Mr. Consumer happy and satisfied. Wider application of these and other principles constituting good public relations will encourage recognition and understanding of the importance of water service.

Construction Works on Show

SPECTACULAR CONSTRUCTION projects carried out by the federal government in various parts of the county have been much in the limelight. As a result of public interest in these undertakings the work of the engineer has received widespread and favorable attention. At Boulder Dam the Bureau of Reclamation's guide service announces that 260,000 visitors have come to see the job; some 5,000 persons looked over the dam and the power houses during the July 4 weekend alone. Boulder Dam is only one (and one of the more remote) projects; a total for all visitors to major projects throughout the country doubtless represents a very large number of persons. The impressions these visitors carry away and the subsequent discussions of what they saw will mean much to the profession in better understanding of the service construction renders to industry and community development.

Doing Its Share

A NOTEWORTHY SHOWING is made by current contract figures, which are now complete for eight months. They fully confirm the indications of the early part of the year that 1938 construction would hold up to the 1937 level and might somewhat exceed it: the current year is ahead by a small margin in spite of last year's unusually heavy midsummer contracts. Thus, while business and the consumption industries went down into the now famous recession, the heretofore lagging industry of construction more than held its own. And, because construction reaches out into many fields of work that produce materials and tools, this stability exerted a beneficial effect on economic conditions generally and is today a measurable factor in helping industry at large to get back into its stride. In turn, general business revival should induce a resumption of industrial plant betterment and of housebuilding, items that are essential to the complete recovery of construction from the big depression. Pending this further advance, it is satisfying to know that construction is doing its share to hold up employment and business activity.

Improving the Form

ENGINEERS will have read with no small amount of satisfaction the observations of C. G. Kaufmann, architectural consultant to the Bureau of Reclamation, abstracted briefly in last week's issue. Mr. Kaufmann, after eight years of experience which includes his notable work in advising as to the proper architectural treatment of Boulder Dam, writes that he now finds himself as conscious of the engineering necessities as are the engineers, and that at the same time the reclamation engineers are as concerned with appearance as is the consulting architect. Mr. Kaufmann characterizes his experience as "broadening and refreshing".

Here is set forth the ideal relationship between architect and engineer. A similar situation is found with respect to the bridges of the Port of New York Authority, where Aymar Embury II is consulting architect. Too frequently architects and engineers look upon each other's functions as unnecessary evils rather than as mutually complementary services. Experience has shown that engineering structures, when correctly designed to take greatest advantage of the inherent characteristics of the material in hand, tend to assume a perfection of form that is esthetically satisfying; but not infrequently the engineer, lacking the trained eye of the architect, falls just short of giving his bridge or dam the last minor change in form that produces a structure satisfying the eye. It is this last touch that the architect "conscious of engineering necessities" can supply.

The two professions should work toward fuller development of these complementary services. Working in harmony they can produce structures that reach new heights in the economical use of materials and still greater perfection in form.

Essential Data

A CAREFUL OBSERVER of economic conditions has said that stabilization of industry should be the first objective of both industrial management and government. But, he added, stabilization is impossible so long as we continue to work in the dark, without definite figures on demand and production and without knowledge of whether they balance or whether one is outrunning the other and upsetting equilibrium. Such knowledge is largely lacking today.

Nowhere is this more true than in the field of construction. The drying up of construction activity after the '20s in the face of many unsatisfied construction needs gave a convincing demonstration of the need for stabilization. In addition to contracting and its army of three or four million workers, the whole range of its supply and service industries was involved, and all of them suffered heavy losses. At least part of these losses could have been avoided had the industries concerned been better provided with facts on production and demand.

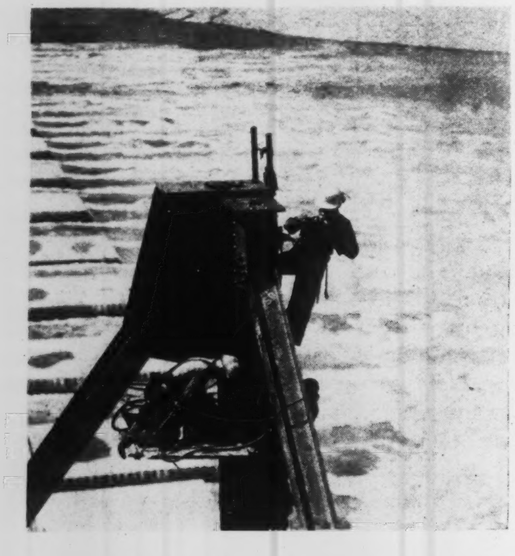
Timely statistics on production and orders are the first essential element of the data needed, but even the best statistics have limited value until coupled with advance estimates of demand. Together, market forecasts and current data on production, orders and stocks would take some of the gamble out of the construction industries' operations.

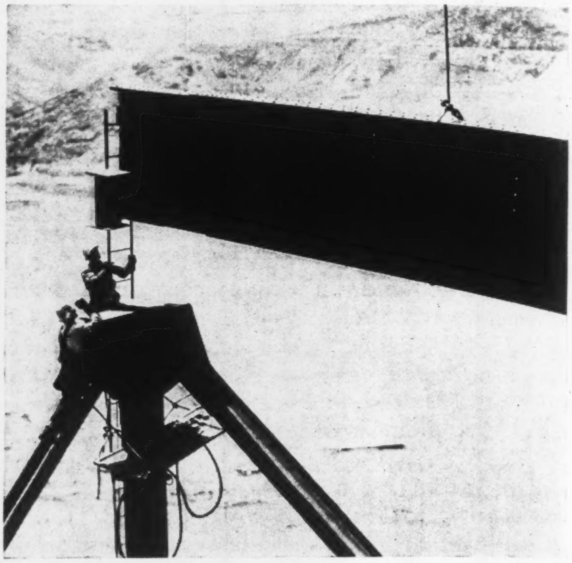
Part of the information required is of the kind that government agencies collect, and the government can make no better contribution to the national wellbeing than to maintain and improve its industrial data service. The facts on which to base forecasts, on the other hand, are largely in the hands of the industries themselves, and therefore the responsibility for realistic appraisal of demands rests on industry rather than on government.

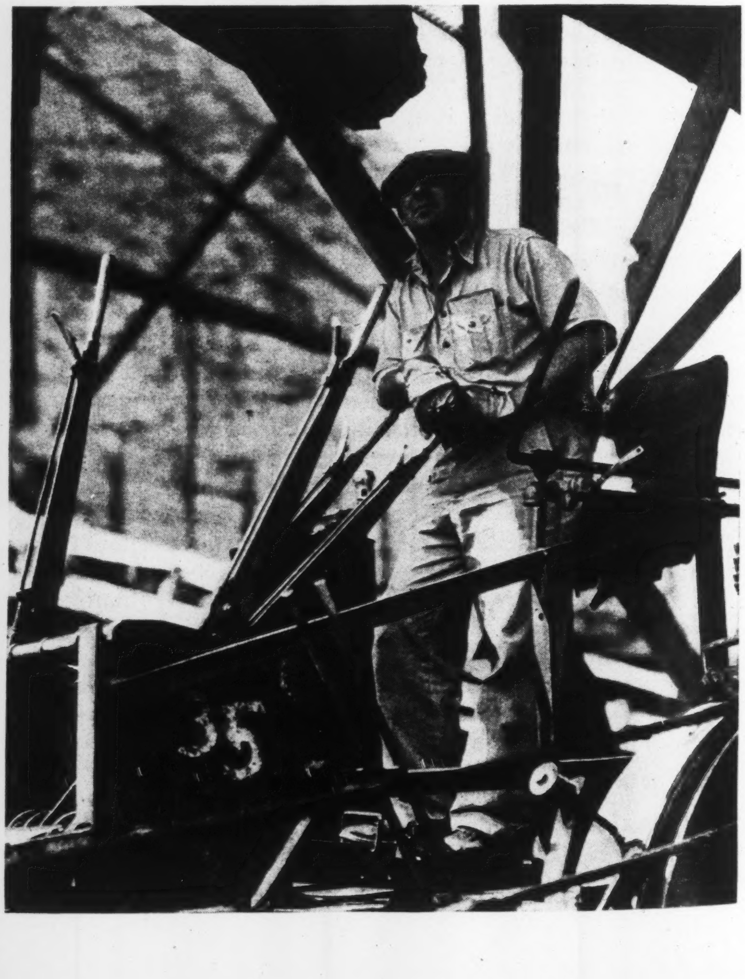
Forecasting is tinged with prophecy, of course, and prophecy has not yet been advanced to a science. There is no standard method of forecasting next year's demand for houses or sewers, for bricks, lumber or steel. Nevertheless men who are constantly engaged in industry are in better position than anyone else to foresee the probable demand for their goods and services, and have in hand the most sensitive indicators of consumption trends.

There is opportunity for each of the industries concerned in construction to contribute its share toward regulation by close and farseeing study of its operations in relation to the prospective currents of demand. With each component industry doing its share, construction as a whole may look forward to attaining greater stability, in its own interest as well as that of the community as a whole.

PICTURES IN THE NEWS







FROM THE HOIST CONTROL cab to the union of steel and steel. these men help in the construction of Grand Coulee High Dam. The steelwork is a part of the 3,600-ft. construction trestle. Thirty-two hundred-odd men—steel workers like these, mechanics, laborers, engineers—work together to raise the dam to its final 550-ft. height.

Bureau of Reclamation Photos

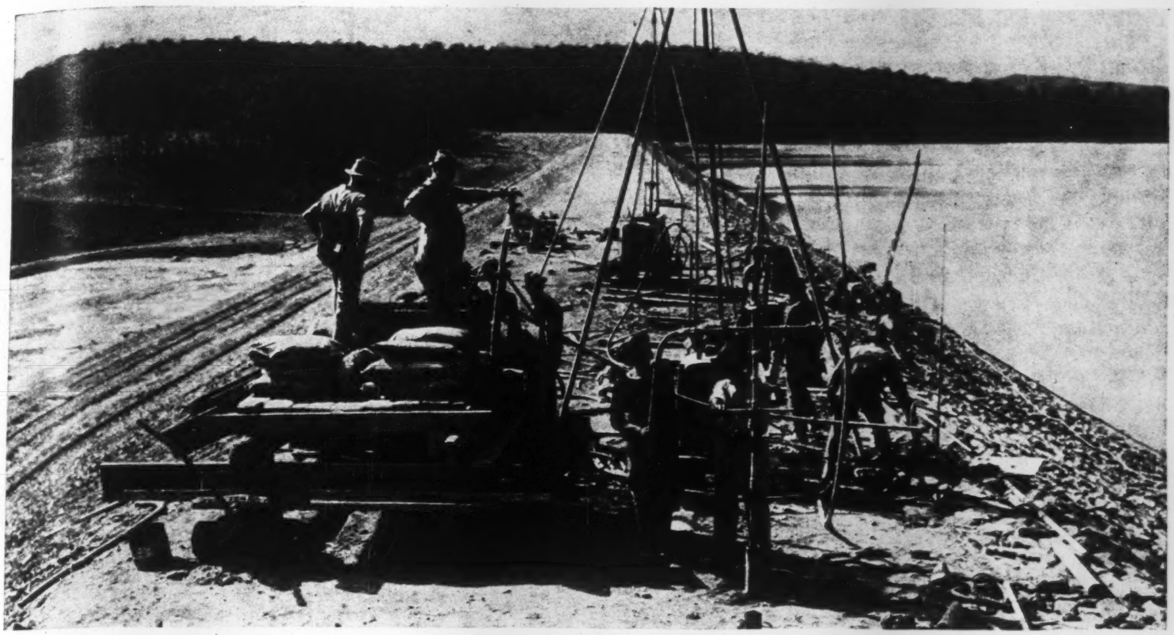


FIG. 1. LOCATING AND GROUTING FRACTURED ROCK IN ALUM FORK DAM

Leakage Stopped with Grout Wall

Stopping leakage through fractured rock in right abutment of dam at Little Rock, Ark., by a grout curtain wall proves most satisfactory method

After the completion of the Alum Fork Dam, which impounds the new water supply for Little Rock, Ark., leakage through the shale and sandstone abutment developed in the north end of the dam. The leakage was not in the dam itself, but in the abutment adjoining the dam, but the engineers were apprehensive lest the seepage might eventually saturate the dam and cause trouble.

Pressure grouting was proposed to eliminate the leakage. It has succeeded in reducing this leakage, bringing it down from 360 to 35 g.p.m. The small remaining leakage comes through solid rock formation 15 ft. below the base of the dam, and it is felt that this cannot cause damage to the dam. In consequence further efforts to eliminate the balance of the leakage were discontinued.

The engineers are convinced that it would have been practically impossible to eliminate this leakage by any other method than grouting. Even had the porous condition of the bed rock below been known it would have been impractical to learn where to grout until leaks developed. The expense of stopping the leakage was only $16,800. Explorations, drilling and grouting before the dam was built would probably have amounted to several times that sum.

Leakage discovered

When the water level of the new lake reached El. 704, a seepage developed in the east bluff south of the dam along contour 700 and continued to increase as the water level rose to 740. The increase in flow was greater for a given rise in head than it would have been for an equivalent pipe, showing that the net area of openings was increasing as the lake rose, and that the leakage was not caused by the flow of water through a single crack or fault at or near contour 700.

As the seepage continued it saturated a part of the downstream toe and later a minor slide occurred. At this time an exploratory trench was dug up the hillside and a drainage trench dug along contour 700 into the toe of the slope of the dam, concentrating the seepage into one stream and drawing it down into the rock below the fill. A 10-in. tile was laid in the trench and the trench was backfilled, restoring the surface and removing the immediate danger to the dam.

Grouting plans

Cement was selected as the grouting material because success has been reported more consistently with it than with any other material. The type of drill to be used was found to be an important factor in the success of grouting because some drills tend to plug up the seams and cracks through which it is desired to pump grout. Diamond point core drills were specified for this job because they not only kept the seam clean, but they also afforded an opportunity to study the formation through examination of the cores recovered.

The program, in general, was to start on the west side of the leak and continue the holes east, grouting the fractured zone and in so doing force the water back toward the east abutment rather than out under the dam.

Two core drilling rigs equipped for drilling 2½-in. holes in rock and recovering 1⅝-in. cores were placed on the job. Three-inch pipe was provided for casing holes through overburden to bed rock. Diamond point bits were provided for drilling in rock.

The grouting equipment consisted of a mixer capable of mixing 64 gal. of water with cement, a grout pan for receiving mixed grout, a positive displacement pump having a capacity of 20 g.p.m., a pressure line to the hole and a return line to the pan for bypassing, a pressure gage, a rubber expansion stop which could be placed at any elevation in the hole and a water meter.

Many of the holes were tested with water applied under pressure. First the expanding stop was set within 5 ft. of the bottom of the hole. If the pressure exceeded 100 lb., the bottom 5 ft. of the hole was considered tight. The stop was then raised 5 ft. and the test repeated and the pressure recorded. In that way the core drilling record was checked against the pressure test as to location of the shattered material.

Grouting reduces leakage

After a hole had been tested, grouting began with the expanding stop set as low as the water test indicated to be necessary. As each zone was grouted to refusal the stop was raised, and finally the casing was capped. Grouting of each zone was started with a thin grout (12 gal. of water to 1 sack of cement) and slowly thickened to 5 gal. of water to 1 sack of cement. Pressures were specified not to exceed 100 lb. per square inch.

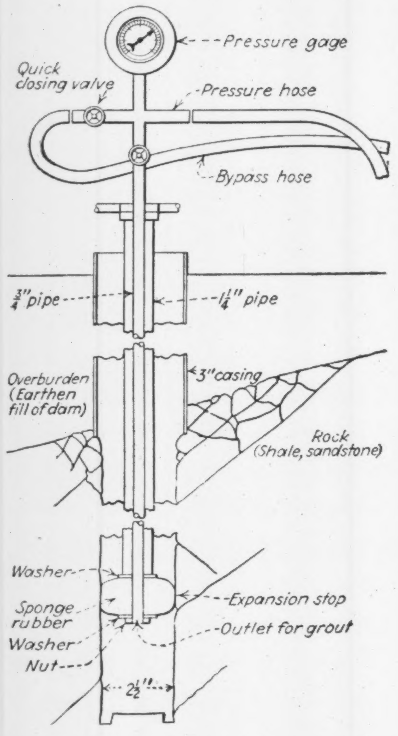


Fig. 2. Arrangements for grouting rock through holes drilled from the surface of the dam.

The first series of holes were started on a line 4 ft. north of the axis of the dam at Sta. 10+50 and continued east on 10-ft. centers to 9+20 (Fig. 3). These reduced the leakage from 360 to 256 g.p.m. The 10-ft. center holes were then picked up at Sta. 9+90 and carried to Sta. 9+50 with a leakage reduction from 256 to 178 g.p.m. One hole at Sta. 9+90 caused a reduction in leakage of as much as 54 g.p.m.

As a further step, it was decided to drill on 5-ft. centers each way from Sta. 9+90. These holes took very little grout and caused little further reduction in leakage. This seemed to prove that all small seams in the shattered surface rock had been sealed off by grout. The problem remaining was that of locating the leaks which were thought to be coming through the grout wall in fairly concentrated flows between Sta. 8+80 and 9+20. Occasionally, cracks were entered which were of such size that the cement grout could not be held in them. In such cases cinders and sawdust were added directly to the hole, followed with water to wash the material into the cracks, and in turn followed with a thin grout.

Finding concentrated leakage

It appeared at that time that the problem resolved itself into finding a hole having a direct connection with a main seam or path of concentrated leakage. Since it was deemed improbable that such a seam could be hit on the original line of grouting without using an excessive number of holes, it was decided to move to a line 4 ft. south of the center line and drill in the vicinity of Sta. 9+90 so that this main seam could be reached through smaller seams not yet grouted. Hole 21 at Sta. 9+92.5 apparently showed a direct and important connection with the leak.

Difficulty encountered

Heavy grout appeared in the tile drain and in an effort to hold this grout, the hole was treated with cinders and sawdust. This process had been used with excellent results in Hole 13 just 8 ft. away, but Hole 21 presented a new difficulty. Here grout was forced up in a nearby hole and no pressure could be built up in the hole being grouted. An effort was made to wash this hole so that it could be grouted later but when tried the hole took very little grout and failed to reduce the leakage. It now appeared that the connection from this hole to the major leak had been sealed off. A circle of holes was drilled around Hole 21 but the major seam could not be reached again. Seven other holes drilled and grouted along this line consumed over 1,100 bags of cement and reduced the leakage only 21 g.p.m.

Still believing that a main seam existed in the vicinity of Sta. 9+90, additional holes were drilled along the water line of the lake 40 ft. north of and parallel to the axis of the dam, but none was to be grouted until a direct connection with the leak was evident. Nine holes were drilled.

Color test employed

Up to this time all holes showing a connection with the leak had shown that connection a very few minutes after application of grout at the hole. No longtime observations were considered necessary until Hole 37 at Sta. 9+80 required the use of fluorescein (a red powder, which, when mixed with water, colors it green and is perceptible in dilutions as great as one part in two-million), was introduced as a means of checking connection with leak. Three hours after application of the dye to the hole, it appeared at the seepage drain. This revealed a new method of approach in locating the main flow, because it

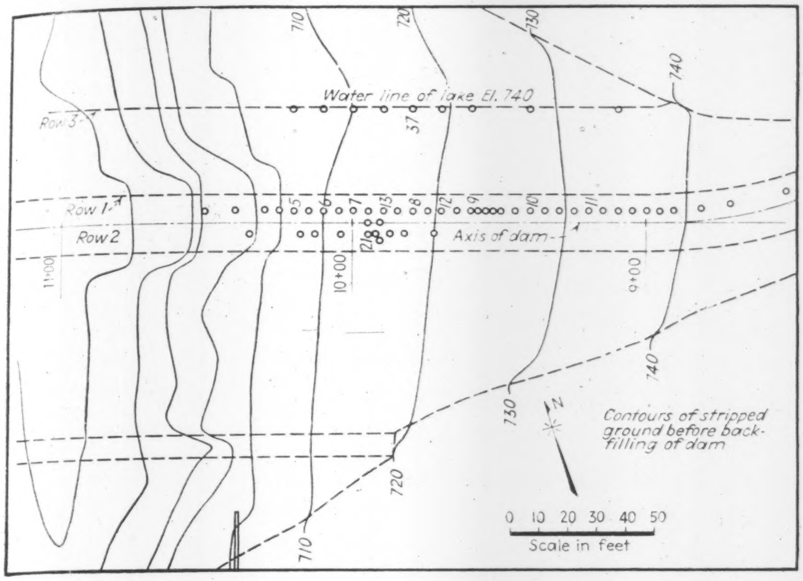


Fig. 3. Plan of the grouted zone, showing the main row of holes.

indicated the velocity at which the water was moving from a hole to the seepage drain.

Since the water level in the holes along the lake 40 ft. north of the dam indicated leakage east of Sta. 9+70, and the fluorescein indicated the closest connection to the main leakage to be at Sta. 9+40, it was decided to leave these holes along the water's edge as observation holes, return to Row 1 and continue to solidify the grout wall to the east of Sta. 9+90. The practice of testing with fluorescein and observing the water level in holes was continued.

Wall extended laterally

Drilling and grouting continued on 10-ft. centers from Sta. 9+30 to 8+70 and one hole was placed at Sta. 8+50. Holes on 5-ft. centers were then placed from Sta. 9+65 to 8+95. Each time a reduction in leakage was effected, a rise and leveling of the water in the observation holes at the water's edge was noted. Finally the water in these observation holes rose to a level 6 to 12 in. below the reservoir water surface, the leakage dropped to 35 g.p.m. and the time of travel of dye from observation hole at the Sta. 9+40 to the seepage drain was over three days. (This hole formerly connected in ½ hr.)

Although the observation holes still indicate some leakage toward the east end of the grout wall, it is believed that flow is not concentrated at one point in the wall, but is an accumulation of many small openings through the wall.

Drilling, materials

A total of 3,400 ft. was drilled, of which 1,940 ft. was overburden and 1,460 ft. was rock. Forty-three hundred bags of cement were used in grouting. The total cost of the project was $16,800 for a reduction in leakage of 325 g.p.m. or $51.60 per gal. per min. reduction.

Conclusions

After the grouting had been completed the engineers concluded as follows: If the possibility of this leakage had been anticipated before construction began a grout wall of at least three rows of holes would have been needed for the entire length of the dam; the additional amount of cement necessary would have off-set the gains in not drilling through the overburden. The cost of removing the fractured rock would have been even greater than grouting prior to construction because some of the water-carrying seams were as deep as 15 to 20 ft. Thus the leakage was stopped more effectively and at less cost after the dam was built, than could have been possible before or during construction of the dam.

The grouting procedure was designed and supervised by Burns & McDonnell Engineering Co., engineers for the Alum Fork Dam. The dam is part of the new waterworks system for Little Rock built with a PWA loan and grant. M. L. Crist was resident engineer.

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Treatment of Industrial Wastes

IMPROVEMENTS in the treatment of certain industrial wastes are noted in recent reports of the Wisconsin Bureau of Engineering by L. F. Warrick, state sanitary engineer.

Malt House Wastes—At Jefferson Junction such wastes are being treated by a trickling filter, but its capacity must be increased to take care of a 25 per cent increase in the amount of barley treated daily. Study has indicated that substantial reduction in the strength of the wastes may be effected by bio-aeration methods, and laboratory experiments are being conducted with a view to combining bio-aeration with trickling filters on a full-scale basis.

Cannery Wastes—Investigation in the treatment of pea and tomato wastes indicates that their pollutional strength is greatly reduced by fine screening, pre-aeration for two hours, and combination with settled domestic sewage prior to final treatment by trickling filter. Ample aeration capacity must be provided in activated-sludge plants receiving municipal sewage containing pre-treated cannery wastes.

Paper Mill Wastes—Laboratory study of the digestion of wood pulp waste with domestic sewage solids indicate that a carbon-nitrogen ratio of 14 to 1 (generally regarded as the limit for satisfactory digestion) may be materially exceeded without detrimentally affecting gas production or other sludge digestion characteristics. The proportion of pulp solids must be increased gradually to maintain a balanced condition in the digester units. Arrangements are being made to intercept paper-mill wastes in the Fox River valley.

French Drains Cure Frost Boils

Colorado county road with high watertable freed from frost trouble by stone-filled trenches

FRENCH DRAINS under the roadway and deep side ditches have done away with former serious trouble from frost heaves and boils on 8 mi. of secondary-type road in Rio Grande county, Colorado. Southward from Monte Vista the road runs through a very flat portion of the San Luis valley where the water table is close to the surface. The French drains consist of a main-core trench some 3 ft. wide, and from 5 to 8 ft. deep, excavated continuously along the centerline of the roadway. Intersecting this at right angles, and spaced at about 200-ft. intervals, are lateral trenches, connecting the core trench to the borrow-pit ditches at the sides of the road. The entire trench system is filled with rock ranging in size from 6 to 12 in. at the bottom to coarse gravel near the surface of the road.

The bottoms of the trenches are so laid out that water drains from a crown point midway between laterals both ways to the nearest laterals and through these to the side ditches. Because of the unusual flatness of the terrain natural drains from the side ditches could be found only at intervals of about 1 mi.; this necessitated rather deep ditches in which, along certain sections fronting farm yards, box culverts or corrugated pipe are placed.

The system has been installed over a continuous section of nearly 8 mi. and this, with an additional 4 mi. on which the drain was not needed, has been brought to grade, and is graveled ready for an oil mat.

Work and Cost

Work was started for the excavation of the drains, Nov. 29, 1935, and was completed July 1, 1936, with an average employment of 90 men throughout the seven-month period of construction. The 7.8 mi. of rock drain cost $4,720 per mile, or $36,821 for the completed drain. A total of 1500 ft. of box drain was constructed to take the place of the drainage ditch in front of farm houses, at a cost of 90c a foot, or a total of $1,350. There were 27,456 cu.yd. of excavation for the rock drain, and 40,600 cu.yd. of excavation by dragline in the drainage ditches on the 2½ miles of ditch completed in August, 1937. It was estimated that 81,200 cu.yd. of earth were at that time to be excavated from the drainage ditches by dragline to bring the frost boil elimination project to full completion.

At the time of completion of the rock drain and 2½ miles of dragline work, a total of $35,955 had been contributed by the Works Progress Administration and $14,055 by the Rio Grande Commissioners. The average man-year cost of the project was $740.

This drainage system proved its effectiveness during the spring of 1937, at which time the road was open for travel at all times. Not a trace of the sub-water was noticeable on the road bed, and during the spring thaw high centers and frost heaves were noticeable by their absence. Traffic went through as never before and in greater volume, with the exception of a few points in the road actually under construction.

County road cleared of water by undersurface stone-filled drains and side ditches with culverts at farm entrances.

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Parking Meter Installations In More Than 50 Cities

MORE than 50 cities ranging in size from 7,600 to 400,000 population have installed parking meters during the last three years in an attempt to solve their downtown parking problems and to relieve traffic congestion, according to the American Municipal Association.

The standard parking fee where the meters are in use is five cents, usually covering a period of one hour. In some cities, however, the parking limit is 30 minutes in the more congested areas. Nine cities installed meters in 1937 and several others have completed installations this year.

In Scranton, Pa., one of the most recent cities to try the metered parking system, half of the meters allow five minutes free parking before a coin must be deposited. The free-period meters are installed alternately with those requiring a coin at the time of parking. (*ENR* July 21, 1938, p. 84.)

Portland, Ore., is the largest city to install the meters this year, while Kansas City, Mo., is the largest where they are in use. Oklahoma City, Okla., was the first city to use parking meters. These meters were installed in July, 1935.

What About Spiraling?

Opinion on the desirability of spiraling curves as an aid to easier and safer driving on highway curves

In *Engineering News-Record*, June 23, 1938, the editor took an opportunity to cast a few doubts on the advisability of using transitions between tangents and curves in highway alinement. Writing to the editor in the issue of July 14, Earl C. Myers of Hastings, Neb., upheld the editor's hands in positive terms. The two have certainly started something. Highway engineers near and afar, even one from England, have taken pen in hand to say in no uncertain terms what they think about spiraling and here is the gist of it.

Joseph Barnett, Senior Highway Design Engineer, U. S. Bureau of Public Roads, Washington, D. C.—Contrary to the thought expressed editorially in the June 23 issue of of *Engineering News-Record*, transitions have not been generally adopted for highways. As far as the writer knows, transitions have not been used on any extended mileage of highways other than roads constructed in recent years in the national parks, in the national area and within the borders of the state of Oregon.

The lack of transitions and inadequate superelevation, or none at all, chiefly account for the practice on the part of most motor vehicle drivers of encroaching on the inside lanes on curves. This dangerous practice is admitted by most drivers and the location of oil marks on the highway is sufficient proof that the practice is general. Transitions must be used if a uniform speed is to be maintained around a curve and the driver encouraged to keep within his traffic lane.

The required length of transition, L_s, may be determined as follows: If a vehicle travels on a curve at a constant speed of v in feet per second it is accelerating toward the center at the rate of $\frac{v^2}{R}$ The total time required to traverse the transition curve is $\frac{L_s}{v}$. The average rate at which the vehicle on the transition approaches this final constant centripetal acceleration is therefore

$$\frac{v^2}{R} \div \frac{L_s}{v} = \frac{v^3}{RL_s}.$$

This average rate varies for different drivers and a great number and variety of tests and observations are needed to determine the maximum average rate that will accommodate almost all drivers. The few observations available indicate that a value of 2 for $\frac{v^3}{RL_s}$ is satisfactory. Equating these values and converting from v in feet per second to V in miles per hour we have

$$2 = \frac{v^3}{RL_s} = 3.16\,\frac{V^3}{RL_s} \text{ and } L_s = 1.6\,\frac{V^3}{R}.$$

There has been some discussion regarding the relation of the length of transition to the length of curve and it has been implied that transitions result in an ever-changing curve throughout its length leaving little or no portion of curve of constant radius. There need be no direct and fixed relation between the length of transition and the length of the central curve of constant radius. Where the proper length of transition for the degree of curvature and the assumed design speed of the highway is used, the length of the central curve takes care of itself. Only curves of relatively short length combined with small deflection angles will be made transitional throughout. While curves transitional throughout have been strongly advocated in England, they have not been generally accepted by the few engineers in this country who apply transitions to horizontal curves. The chief objection to this type of curve is that there is too sudden a change in the slope of the edge of pavement with respect to the center line at the point where both transitions meet.

Among the reasons for the failure of highway engineers to adopt the practice of applying transitions to highway curves are: reluctance to change existing practice and to revise standards; a belief that a vehicle using the highway is not confined to a track and is able to effect the change from a straight to a circular motion smoothly; and a belief that widening at a sharp curve together with the gradual attainment on this widening accomplishes a satisfactory transition. Some of these reasons were valid when road speeds were lower than at present but they do not apply now.

It has also been a belief of many highway engineers that transitions involve tedious calculations both in the office and field, resulting in increased cost of engineering. It must be admitted that extra work and, frequently, delays in the field result where alignments are first projected as tangents and simple curves and later adjusted for the insertion of transitions; numerous trial-and-error adjustments frequently are necessary. This should not have discouraged the use of transitions by a profession which, in the normal course of events, generally handles much more complicated work. However, to eliminate the tedious trial and error involved in the application of transitions for highway curves, the U. S. Bureau of Public Roads has prepared a set of tables with which it is practicable initially to project an alignment including the necessary transitions for horizontal curves eliminating trial and error, subsequent adjustments and field delays. It is believed that, with these tables, it is just as easy to design and locate curves with transitions as it is to design and locate alignments consisting of tangents and simple curves. These tables are now in the hands of the government printer and will soon be available for a nominal sum, by applying to the Superintendent of Documents, Washington, D. C.

A. J. Schamehorn, Director, General Motors Corp. Proving Ground, Milford, Mich.— It is true that there is no use spending money for spiral easements unless the utility and safety of the highway is improved at least in proportion to the cost. We analyzed this problem carefully before building our high-speed loop, and the result of the study was that we finally used carefully constructed easements on the four curves that we have in this 3.8-mi. course, three of which have 1,000-ft. radius. After having used this track for about twelve years now, under all conditions of weather, we are in a position to say that it would undoubtedly have been a great error to have failed to incorporate the easements.

We are unable to agree that one has continually to correct car steering on a road so constructed nor are we able to understand why one need change the speed of a vehicle at all on a curve so constructed. Our cars—any cars—will travel a curve with proper superelevation and easements without change of speed and without steering the car at all. This is our experience and we consider the cost and trouble of building our roads this way has been returned to us many times over in the absence of accidents and the absence of congestion on our road system.

This letter is in no sense written with the desire of prolonging an argument, but as years pass and our public road systems are improved, it is hoped that distances between cities will be shortened — time-wise — through higher but safer motor vehicle speeds. As a part of such a program, it would seem that spiral easements on curves with proper superelevation are an absolute necessity.

John A. Wilson, Wentley, England—That the very construction of a motor car automatically spirals its travel is a rather generally accepted assumption but I am unable to find anyone who has actually analyzed its motion. It is hoped that the comment in the editorial of June 23 may lead to a critical analysis of the natural trajectory of a car with steering set for diversion from a tangent and the spiral derived from geometry only.

C. H. Garriss, Federal Contact Engineer, State Highway Commission, Raleigh, N. C.—There is ample evidence that spiraled curves are safer and afford more comfortable riding than simple curves. I was employed by the Louisiana Highway Commission over eight years ago when they initiated their first big highway program. During this program all curves on paved highways and other important roads were constructed with transition curves of varying lengths. I have heard much favorable comment on the riding quality of the curves in that state and no unfavorable comment on account of the existence of transition curves.

I have never had experience with curves transitional throughout their entire length and do not believe this practice would be desirable except for curves having very small central angles. As to speed, all curves should be so constructed that no reduction in speed is required. Any curve which, of necessity, is built with such a radius that a reduction in speed is necessary should be properly marked whether or not transitions are used.

To make the horizontal adjustment from tangent to curve requires a certain interval of time. The distance traversed in this interval of time varies with the speed, requiring a longer transition for higher speeds. An adjustment of this sort made suddenly would result in skidding. If the transition is properly constructed, this adjustment can be made by the driver almost without effort, particularly where the superelevation runoff is equal to the length of the transition curve with the rate of superelevation at all points proportional to the degree of curvature.

For some time the state of North Carolina has been using transition curves on paved roads with excellent results. The standards used in designing these transitions are based on the most advanced data obtained from the Bureau of Public Roads and other sources. I believe that a comparison of the curves now being built and those built a few years ago in this state would be sufficient to convince anyone of the desirability of employing transition curves for highway purposes.

R. H. Baldock, State Highway Engineer of Oregon, Salem, Ore. — Some years ago the question of spirals was debated among highway engineers and the arguments used against spiraling were the same then as now, notwithstanding the fact that both the mathematical computations and the observed effect of the use of transition curves in highway practice entirely disprove the arguments against them. In fact, highway curves have always been spiraled; that is, many drivers cause the vehicle to move in a curve offset to the simple curve which closely approximates the spiral. Due to the fact that most of the earlier curves used in highway construction were so sharp and so frequent, vehicles traveled at slow speeds and a shift of this kind could readily be made. The length of the spiral varies as the cube of the speed, hence slow speeds were necessary because the width of the road did not permit the amount of shift necessary for long spirals. This practice, familiarly known as "cutting the curve", is beset with great hazard and is undoubtedly one of the foremost causes of head-on collisions on curves.

It is the writer's opinion that a correctly superelevated, spiraled, long-radius curve can be driven at the designed speed with no more discomfort than is present when driving a tangent. Experience has shown that the use of the spiral gives a distinct advantage and tends to hold the vehicle in its proper lane.

Spirals have been used in the state of Oregon for a number of years. The spiraled sections can be driven at a continuous speed over both tangents and curves, whereas on the older sections without spirals the speed must be decreased on entering curves in order to avoid the rapid change in centrifugal acceleration. If for no other reason, the use of spirals is justified in highway practice because of the ease in accomplishing the runoff of the superelevation from the circular curve to the tangent, eliminating the old rule-of-thumb methods, which are wrong from the standpoint of both mechanics and aesthetics.

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Standard Materials Used In FSA Housing

THE Farm Security Administration has now built over 38,000 structures in 160 projects at a total cost of about $62,000,000. In the early stages of the program the ratio of labor and material costs was 65:35; this has now been reversed so that now only 35 per cent is being spent on labor and 65 per cent on materials.

In developing designs for low-cost house construction the Farm Security Administration, according to Capt. R. B. Lord, coordinator and director of construction, has adhered to certain policies intended to obviate unnecessary costs. These included the requirement that only standard materials procurable in quantity through established manufacturers or dealers be used and that these be so utilized as to reduce labor costs in the field to a minimum.

Designs were prepared by architects, were then reviewed by designing engineers responsible for reducing material usage, and were then checked by field construction men. In following this procedure one design was revised six times and in each case a cost saving resulted.

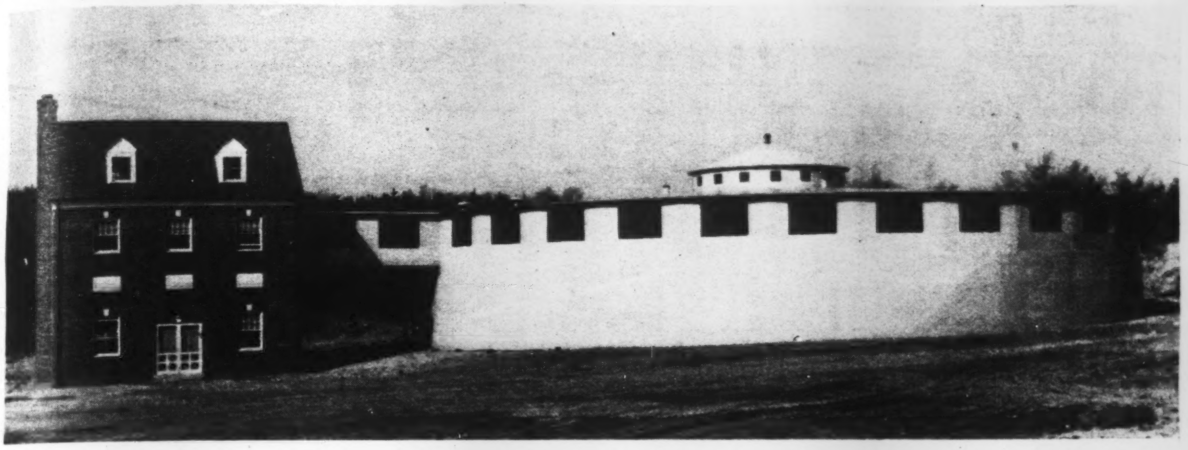


FIG. 1. BRISTOL'S STEEL TANK TREATMENT PLANT ADJOINING WHICH IS THE PUMP AND CHEMICAL STORAGE BUILDING

A Water Plant in a Tank

Bristol, Conn., has a new water treatment plant with all the units housed in a circular steel tank with concentric sections

BRISTOL, CONN. recently completed the installation of a new water treatment plant in which the filtration, mixing and coagulating facilities are all housed in a circular steel tank divided into concentric sections. This unique type of construction follows the pattern of a similar plant designed by the late Robert C. Morse, and built at Burnt Mills, Md. about four years ago.

As shown in the sectional sketch (Fig. 2), the tank is divided by concentric walls into three sections. Around the center space, the lower portion of which serves as a pipe vault, are grouped four sector-shaped filters and surrounding these in an outside annular space are the settling basins. The plant capacity is 5 m.g.d.

Raw water is pumped from a reservoir adjacent to the filter plant through a 20 in. line by two $1\frac{1}{4}$- and two $2\frac{1}{2}$-m.g.d. low lift pumps. It flows by gravity through the plant and then to the filtered water storage (two steel tanks of 400,000 gal. each) which are connected with the distribution system.

Coagulating chemicals are added to the raw water at the pumping station. The treated water entering the plant first receives quick mixing with an air agitation device and then passes into two small mixing tanks for 15 minutes of detention. From here it enters the coagulating basins which have a detention period of four hours. The aeration, mixing and coagulating basins are in duplicate so that any unit may be taken out of service without interrupting the operation of the plant.

Filter details

Water flowing over a skimming weir at the outlet end of the coagulation basin passes through the pipe vault where it is distributed to four rapid sand filters. The filters, with a sand surface area of 434 sq.ft., are supported on a perforated steel plate, and this in turn rests on a steel grating. The beds consist of 18 in. of graded gravel and 24 in. of Cape May sand.

Filter effluent is discharged into a tile-lined steel pipe well in the center of the pipe vault which extends above the operating floor. From there it flows through a 20-in. main to the pump house where the lime is added previous to its discharge into the filtered water reservoir.

The plant is of welded steel plate construction and is 118 ft. in diameter. The concentric steel shell form-

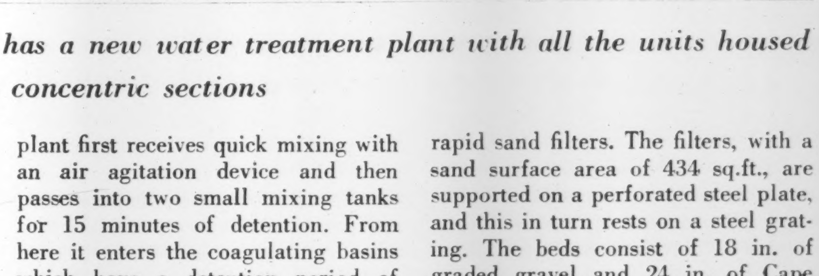


Fig. 2. Arrangement of the concentric sections in the steel tank. In the center is the pipe vault which in turn is surrounded by the filters and the coagulation basins.

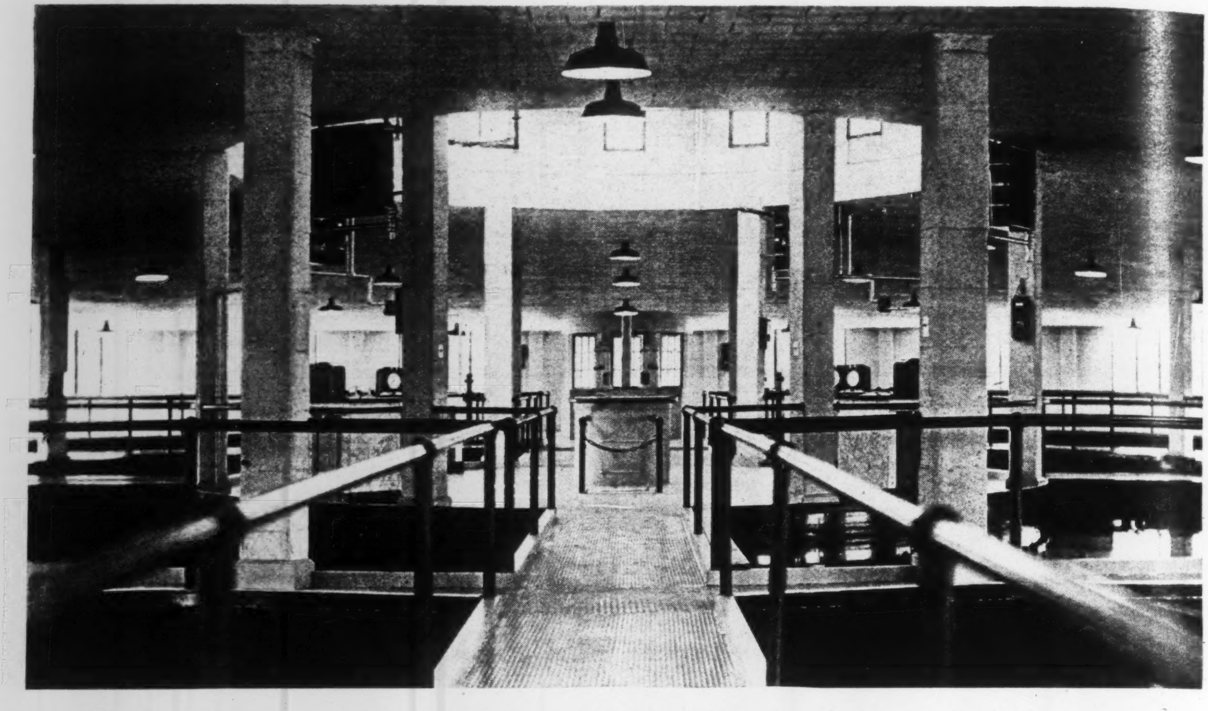


Fig. 3. Maximum use of minimum space keynotes the design of the plant as illustrated by this interior view.

ing the interior filter units is 55 ft. in diameter. Interior walls above the operating floor are covered with cork. 1½ in. thick. Steel surfaces in contact with water are protected by four coats of special paint while other exposed surfaces have three coats.

The filter assembly is entirely inclosed, the steel structure extending to a height of one story above the top of the water line in the various basins. A monitor section, 4 ft. higher than the main building, covers the operating floor area. Circumferential steel walks with pipe rail are located around the entire inside of the outside wall and around the filter shell; radial steel walks connect these with the operating floor at the quadrant points.

The information and pictures on which this article was based were obtained from the Chicago Bridge & Iron Co., who erected the plant. James A. Newlands, consulting engineer, Hartford, Conn., designed the plant.

Setscrews Take Strain off Corporation Cocks

WHERE 1½- and 2-in. corporation cocks are inserted into cast-iron water mains in the Los Angeles system such connections are made more secure by equipping the corporation cock with a special flange on its inlet side. This flange is about ¾ in. thick, cast integral with the fitting and has a triangular periphery. It is drilled and threaded for three ½-in. bronze setscrews; two of these screws are on the bottom of the flange where bracing is most required. After the corporation cock is properly screwed into the wall of the main these setscrews are backed from the flange until they tightly contact the main. When this is done they brace the corporation cock so that to break the connection it has to be practically pulled straight out of the tapped hole in the main rather than broken off in bending as would be possible with the standard connection.

The efficiency of these braces was tested by connecting a 2-in. pipe to the corporation cock and loading the pipe heavily. Under a strain greater than would ever be likely to occur in actual service, the braces held the connection firmly in place.

As an added protection a bronze fitting with a bell end is screwed onto the corporation cock. The service connection pipe then is leaded into the bell so as to make a flexible joint to compensate for any heavy settlement or other deflection in the connecting line.

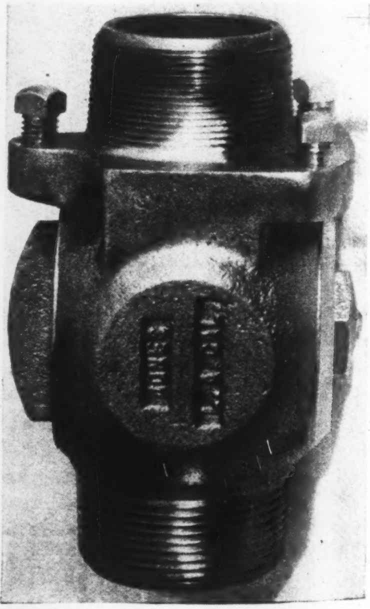


Fig. 1. Corporation cock of new design

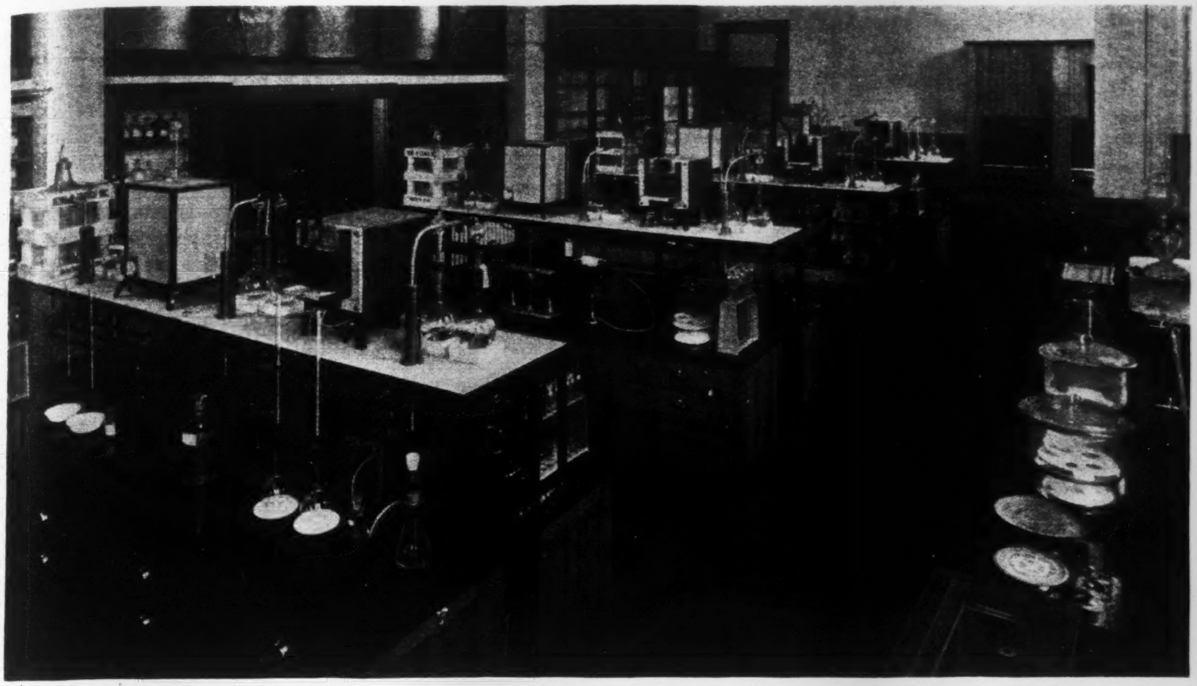


FIG. I. COMPLETELY EQUIPPED TABLES FOR INDIVIDUALIZED STUDY IN THE ANALYTICAL LABORATORY

Tools For Sanitary Research

Gordon M. Fair and Edward W. Moore
Harvard Graduate School of Engineering, Cambridge, Mass.

Flexible, small-scale equipment at Harvard provides the means for basic instruction as well as research in sanitary engineering

What is the function of a laboratory of sanitary engineering and what facilities should it possess to best serve its purpose? With a background of long experience whetted by critical observation, Prof. Fair and his colleague, Prof. Moore, are particularly well qualified to answer this question. Current interest and progress in water and sewage treatment lend a special timeliness to their discussion. — Editor

It is an axiom of the laboratory method of instruction that the equipment and procedures employed shall acquaint the student with the principles and techniques underlying the subject studied. Laboratory instruction in engineering schools should exemplify the operation* of the forces with which the engineer has to deal, the behavior or properties of materials, structures or machinery, and the measurement of their controlling characteristics. There is no reason why laboratory instruction in sanitary engineering should differ from these tenets. Yet, in the past, there has been in this field of learning a dearth of properly designed experimental equipment and well formulated laboratory exercises outside of basic instruction in water and sewage analysis. All too frequently, too, there has been a failure to bring to the fore the scientific principles upon which the performance of sanitary works is based.

Single large-scale models of water-purification and sewage treatment works, often incorporated in laboratories of sanitary engineering, will not do it. They are too inflexible, require at best successive rather than concurrent study of differences in operation, and usually demonstrate the effects of multiple variations rather than the influence of individual operating factors. For the same reason they do not lend themselves to fundamental research. Also they are needlessly expensive in installation, space requirements and operation. The studies that are permitted by such equipment are better carried on as field exercises at sanitary works.

With these considerations in mind, the laboratory facilities designed by the authors and their associates is devoted to the demonstration and investigation of basic principles by means of simple, flexible and individualized equipment. Some of this equipment is described and illustrated herewith.

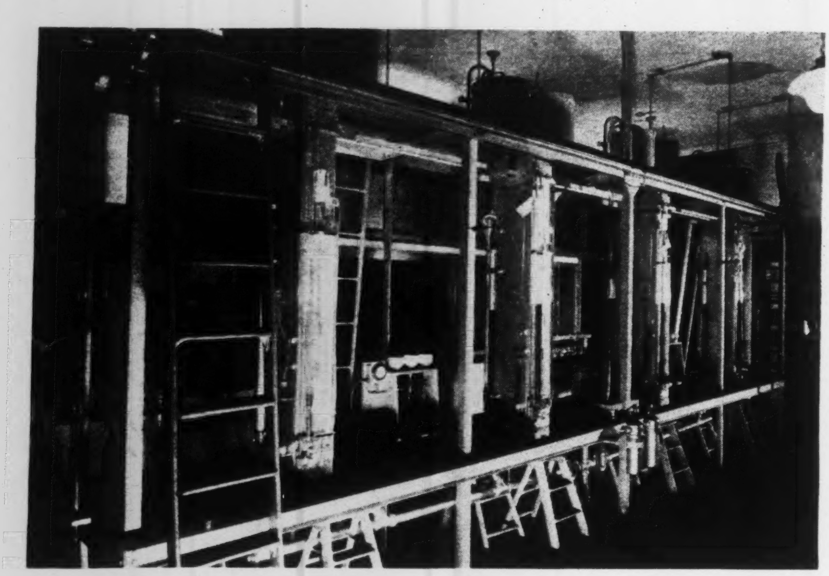


Fig. 2. Experimental center of the water purification laboratory. Equipment is provided for aeration, sedimentation and filtration studies.

The laboratory includes facilities for the physical, chemical and biological examination of water and sewage and for studies in water purification and sewage treatment, a dark room for photomicrographic work, a low-temperature room and several research rooms. Two laboratory boats for field work in limnology, and a wide variety of equipment for the collection and analysis of samples in the field and for the study of existing sanitary works completes the experimental resources of the laboratory. The laboratories of industrial hygiene and air conditioning which form part of the group of laboratories devoted to instruction and research in sanitary engineering will not be described.

Chemical laboratory

The rooms equipped for the analysis of water and sewage follow the normal pattern of such laboratories. The chemical laboratory is shown here (Fig. 1), because the superstructure of the benches illustrates how the student analyst has been provided with equipment that is not generally individualized in laboratories of this kind. It will be noted that this structure carries individual ammonia stills, an electric furnace, a drying-oven and a distilled-water tank in addition to the common laboratory services. Only the balances and pH comparators are not within the analyst's immediate reach.

The experimental center of the water purification laboratory (Fig. 2) is a two-storied steel and wood framework. This unit supports the equipment for experiments on aeration or gas exchange, sedimentation, filtration through sand beds, softening by zeolite filters, taste and odor removal by beds of granular activated carbon, and correction of corrosive properties by contact with marble.

For the study of aeration there are two types of equipment: One for the exchange of gases between droplets and the atmosphere, the other for the exchange of gases between gas or air bubbles and water. They will be described here because they illustrate how simple materials available in most chemical laboratories may be utilized to demonstrate the operation of one of the fundamental forces encountered by the sanitary engineer.

For droplet aeration separatory funnels are attached to the uprights of the frame at various heights and centered above Nessler jars. Water charged with carbon dioxide or other gases or deaerated under a vacuum drops from a glass nozzle attached to the separatory funnel and is caught in the Nessler jar under a layer of mineral oil. A film of this oil rides also on the water surface in the funnel; unwanted gas exchange is thus excluded. The droplet size is measured by counting the number of droplets discharged by the nozzle into a small graduate. The time of exposure is given by the height of drop. The concentration of the dissolved gas in the funnel and in the collecting jar is determined analytically.

For bubble aeration, a compressed gas such as oxygen or carbon dioxide is discharged from cylinders through glass nozzles into the bottom of glass standpipes and escapes at the top. The size of gas bubbles is measured photographically and their number

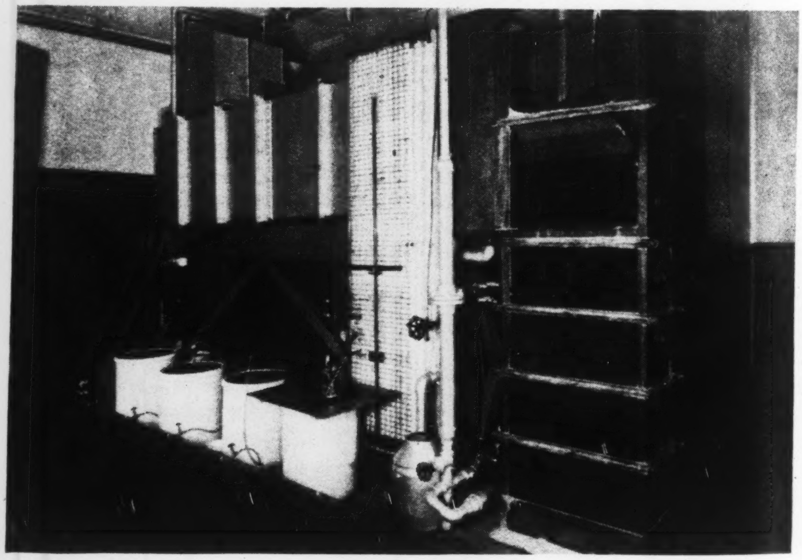


Fig. 3. Coagulation basin (upper left) and sand filter (right) are large scale models which have been converted to other uses. The four 15-gal. crocks are used for activated sludge studies.

counted. The concentration of the gas absorbed by the water is found by analysis.

The settling velocities of sand grains are determined by observing their time of fall through water in a long glass standpipe attached to one end of the frame. Familiarity is acquired experimentally with the hydraulic resistance of particles, as expressed by Stokes' law and the laws governing the transitional range of sedimentation.

Filter sand, zeolite grains, granular activated carbon and marble chips are placed in glass tubes mounted on the four sides of the central columns of the frame. Water of the desired quality is supplied to them from carboys supported on the top platform. The sand filters are of conventional design and contain sands of different size and uniformity. A series of gage tubes permits reading the head losses in filtration and expansion. To study the hydraulic behavior of sand beds, deaerated water is used, because the release of air from the water interferes seriously with flow. The water is deaerated by spraying it into a carboy that is held under a vacuum. All carboys are placed in earthenware crocks.

Coagulation investigations

For experiments on the coagulation of water and sewage and the chemical conditioning of sewage sludge, a series of commercial laboratory stirrers has been equipped with a lighting system which projects a Tyndall beam through the liquid. Detection of floc formation in transparent fluids is greatly facilitated. The stirrer itself comes equipped with variable speed motor and revolution counter. For illumination it has been mounted on a rectangular steel box, which contains an automobile head lamp and a bulls-eye lens for each stirrer. Floc formation is viewed against a black background.

That once upon a time our laboratory, too, employed large scale models is shown in Fig. 3. Today the large metal tank, which was used as a coagulation basin, is equipped with dosing tanks and baffling devices for model studies of the relationship between theoretical detention period and actual flowing-through time in sedimentation and coagulation basins. A twin dosing tank, controlled by quick-acting valves, allows the basin influent to be charged with salt or dye solutions without disturbance of flow.

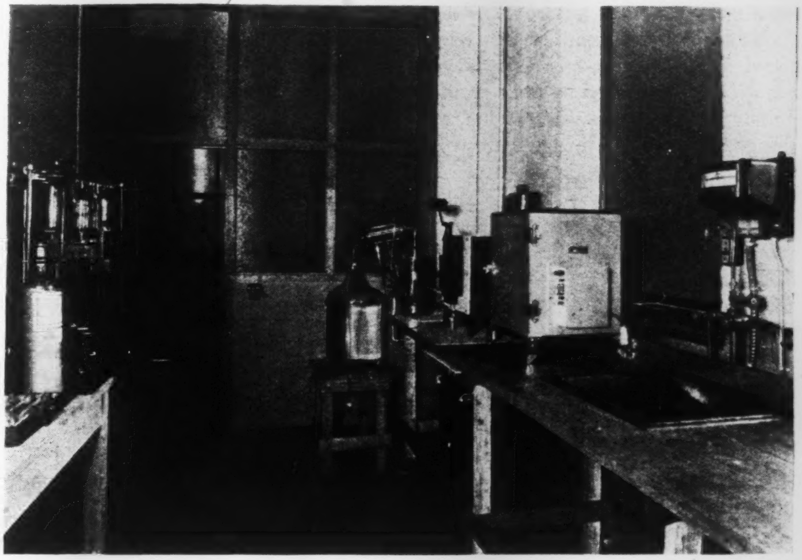


Fig. 4. Laboratory equipped for special research problems. Automatic temperature control of the electric furnace is provided by the wall-mounted pyrometer.

The time of travel of the salt solutions is followed by means of a conductivity meter connected to electrodes that are situated at the outlet of the tank. The glass-sided sand filter model shown in Fig. 3 has been re-equipped for the demonstration and study of air scour, surface wash and high velocity back wash phenomena.

Sewage treatment research

The experimental equipment provided for the study of the activated sludge process, too, is very simple. Fifteen-gallon crocks are equipped with diffuser bulbs fed from the laboratory compressed air line. The tanks appear in Fig. 3, to the left of the filter.

The digestion of sewage sludge at different temperatures is carried on in a bank of thermostatic baths which can be maintained at any desired temperature from 75 to 175 deg. F. The temperature control equipment of these baths consists of a sensitive bi-metallic thermoregulator, knife-blade type heaters, and variable-speed stirring motor. The closed vessel of sludge, totally immersed in the bath, is connected to an individual gas collector designed to cut diffusion losses to a minimum, and to permit accurate analysis of all gas evolved. The baths are large enough to accommodate several containers and are used also as incubators when making high-temperature biochemical oxygen demand studies.

One of a series of assemblies for the study of vacuum filtration of sewage sludge is shown set up on the filter frame in Fig. 2 (left center). The apparatus consists of three Buechner funnels connected to 100 c.c. graduates. The graduates are interconnected by a manifold which is also provided with a vacuum gage and a bleeder for controlling the intensity of vacuum by admitting small quantities of air. The manifold is connected to an aspirator pump through a large carboy which acts as a stabilizing vacuum chamber. Filtration can be carried on at any desired vacuum up to about 28 in. At suitable time intervals, the volume of liquid filtered from the sludge is read and the results give the percentage of moisture remaining in the sludge.

For special problems

Part of one of the research laboratories is shown in Fig. 4 to illustrate the type of equipment provided in making a study of special problems. The large drying oven, water still, and precision gas analyzer are of standard design. The large electric furnace, used for volatile matter determinations on water, sewage, sludge, and mud samples, is exceptional in that its temperature is automatically controlled by the pyrometer mounted on the wall at the extreme right. This instrument will maintain the furnace temperature at any desired value from 200 to 1,000 deg. C. with a temperature accuracy between the narrow limits of plus or minus 5 deg. C.

Special features of the research laboratories are the dark rooms that are used for photomicrography or for biological experiments requiring the exclusion of light, and a large cold room that is designed to operate at about 38 deg. F. The cold room is equipped with individually heated incubators and thermostatic baths that are used for experiments at temperatures between 38 deg. F. and normal room temperature. Decomposition of organic matter at temperatures from 38 to 70 deg. F. requires special study, since the temperatures of most sanitary works and natural bodies of water lie within this range during all but the warmest seasons of the year.

An objection that may be voiced to equipment of the type here described is that the results obtained are circumscribed by the smallness of the scale upon which the investigations are conducted. This objection becomes invalid, however, if the samples are properly prepared and the means of measurement are made sufficiently precise.

Dusting Reservoirs With Chemicals

Los Angeles uses a portable "scatterer" to spread dry chemicals in open bodies of water

SUCCESSFUL USE of a blower device to scatter copper sulphate in dry form for the control of algae in the reservoirs of the Los Angeles Bureau of Water Works and Supply (*ENR*, May 28, 1936, p. 788) has led to the application of this scheme in the distribution of other dry chemicals. Thus far alum, calcium hypochlorite, ammonium sulphate and activated carbon have been applied and the results have shown far greater economy and effectiveness than could have been secured by any other method previously used, according to R. F. Goudey, sanitary engineer of the department.

The scattering device consists of a hopper with an orifice opening in the bottom in which a four-armed revolving scraper keeps chemicals in a feeding condition; a blower into which the chemical is sucked and then discharged from a nozzle which can be rotated in a half circle; and a direct-connected 4-hp. gasoline motor. The three units are mounted on a skid which can be easily transported for mounting on the back of a boat and thus used at any reservoir where treatment is needed.

Alum was distributed in a 40-m.g.d. reservoir roiled by storm flood waters to obtain a dosage of two grains per gallon; this reduced the turbidity to less than 10 p.p.m. As much as 10 tons were spread in this manner. On another occasion, 5½ tons of calcium hypochlorite was applied to a reservoir in a 6-hour period to destroy an algal growth. Previously, it required two weeks time to treat this reservoir with an equivalent chlorine dose using standard chlorinators mounted on barges. Ammonium sulphate mixed with calcium hypochlorite to form chloramines has also been applied.

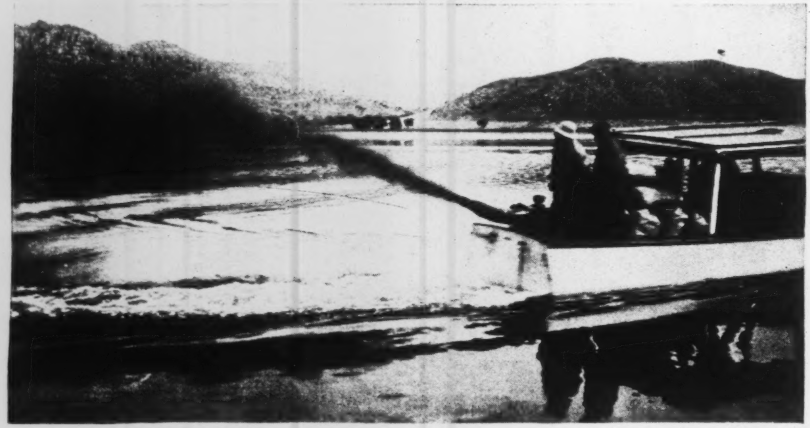


Fig. 1. **Scattering dry chemicals in reservoir with a blower device has been successfully developed at Los Angeles. This view shows the application of activated carbon.**

• • •

Water Plant Operation at Kansas City

IN THE North Side purification works of the water department at Kansas City, Mo., the theoretical detention period, based on rated capacity, is 17 hours, divided as follows: pre-sedimentation, 4 hr.; chemical mixing, ½-hr.; primary coagulation, 9 hr.; final coagulation, 3½ hr. A clear well storage of 3,000,000 gal. is provided.

To the 23,780 million gallons of water treated during 1937, there was added an average of 329 lb. of alum and 183 lb. of lime per million gallons; ammonium sulphate dosages averaged 6.2 lb. The water pumped to the city received an average dose of 7.4 lb. of chlorine. All the alum used (some 3,000 tons) was manufactured by the department, at a cost of $13.78 per ton for material, power and labor, or $15.25 per ton delivered to the storage bin, including maintenance parts and labor, interest and depreciation. Total cost of purification was $8.86 per million gallons, of which $3.56 represented the cost of chemicals for sedimentation and sterilization. These figures are given in the annual report of T. D. Samuel, Jr., chief engineer and superintendent.

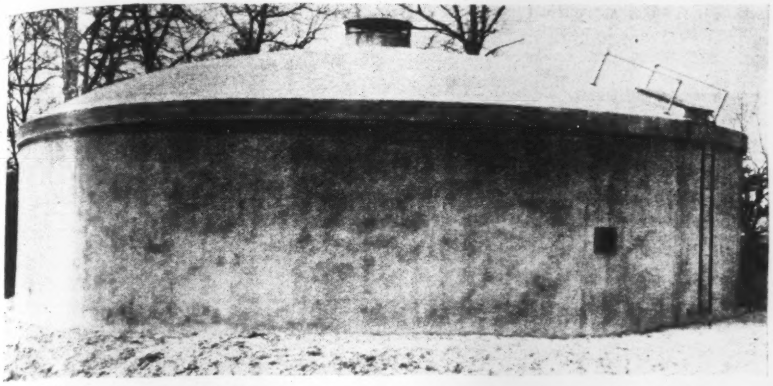


FIG. 1. WATERWORKS RESERVOIR AT OAKLAND, MD.

Low Cost Water Storage

D. E. Davis
The Chester Engineers, Pittsburgh

Air-shot mortar ingeniously applied to thin wall and roof construction for a small waterworks reservoir

A CIRCULAR TANK reservoir recently built for the waterworks of Oakland, Md., is an interesting example of thin wall and dome construction of air-shot mortar, or shotcrete. As shown by the illustrations the tank is partly buried in the ground; it holds 325,000 gal. with a water depth of about 22 ft. Other dimensions and the essential structural elements are shown in Fig. 2.

The contractor, the Cement Gun Co. of Allentown, first shot the floor, leaving an ample keyway for the wall. He employed rough unplaned boards placed vertically for his wall forms; the inner surfaces were placed 1 in. in from the final outer wall surface. The first layer of vertical and horizontal steel reinforcing bars was fastened to the inside of the forms and covered with about 1 in. of Gunite. The second layer of horizontal bars was subsequently erected and fastened to, and midway between the previously placed bars, then covered with another $1\frac{1}{2}$ in. coating. After this had set, two unreinforced inner coatings, of $1\frac{1}{2}$ and $\frac{3}{4}$ in., respectively, were shot in place, making a total thickness of 5 in. The surface of each coat was screeded with a sharp trowel to take off any irregularities and to remove any rebound which may have remained from the previous shooting. The last operation on the interior of the tank was the application of a $\frac{1}{4}$ in. flash coat.

After the forms were removed and the exposed surface cleaned with compressed air and water, a light wire mesh was placed around the wall over the entire outer periphery, and the final 1 in. seal coat applied. This outer surface was screeded and then given a flash coat employing a mixture of cement with finely screened sand of fairly moist consistency. This coat gave a fairly smooth and finished appearance to the completed structure.

Wire-mesh sheets were used for reinforcing the roof, the vertical wires being placed as nearly radially as possible, with considerable overlap at the upper edges of the sheets. A second layer of wire mesh was installed in an 8 ft. ring around the outer edge and thoroughly bonded into the reinforcing ring at the haunch of the dome. A ring of about 4 ft. wide was first shot around the outer edge of the tank and, on the following day, the remaining roof was shot, beginning at the dome and working downward in rings. The roof was shot in rings of full thickness so as to prevent stratification or laminations which might result from rebound. Water and air under high pressure was employed in removing rebound from the exposed forms and from the edges of previously placed rings before applying the succeeding rings. The roof supports were left in place for about seven days, and the signal for their removal was given by the slight rising of the roof away from the forms, indicating that it was acting as a dome.

Two layers of horizontal steel were used instead of one heavier layer to minimize or eliminate the development of sand pockets. Ample overlap was provided where required, but precautions were taken to see that horizontal bars did not touch, but were far enough apart to permit completely surrounding them. The fastening of the first layer of steel directly against the forms gave assurance of

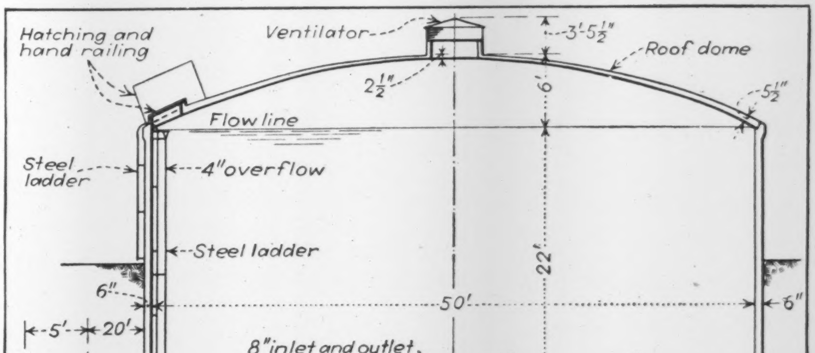


Fig. 2. **Thin walls and roof of the reservoir were built up of several layers of shotcrete. The roof was designed as a dome.**

firm support and accurate location, but made it possible for some sand to gather between the back of the rods and the forms. When the forms were taken down, and the exposed surface washed down with compressed air and water, a clean surface was exposed, which afforded an excellent bond for the outer coat. free of all sand, thus preventing sand pocket formation, which is most important for water tightness.

The aggregate was a crushed, friable conglomerate which was practically pure silica, and was mixed with cement in the proportions of 1 part cement to 3 parts sand. Enough water was added at the mixing nozzle to give a product which was moist but would not sag from vertical surfaces when placed in a thickness of 1½ in. An effort was made to maintain a nozzle velocity of about 400 ft. per sec., but the actual application rate was left largely to judgment.

The bids for the reservoir were respectively $9,206. $9,470. $11.200 and $11,830, and the contract was awarded to the low bidder. The Cement Gun Co., Inc., Allentown. Pa.

Efficiency in Water Service

W. W. DeBerard

Associate Editor, Engineering News-Record

The Indianapolis water company, largest privately-owned system in the country, provides an example that all water supply management will find interesting

Operation procedure, maintenance methods and production control as practiced by the Indianapolis Water Co. are considered over the country as especially meritorious and effective. A good product, a reasonable price, modern merchandising and an interested expert personnel are the means by which the company renders satisfactory service. Education of the customer to these quality factors in the company is the job of a publicity staff.

The company's principles are: The product must stand up, the price must bear a proper relation to production cost, the method of sale must be equitable (meaning through a quantity measurement). and the staff must know its product and serve consumers courteously.

Long imbued with the idea that this largest private waterworks system was above average in all these qualities, it seemed natural to visit Indianapolis for the purpose of investigating the inner workings of the company. Although I had known and visited the plant at intervals over a period of more than a quarter of a century, a comprehensive survey of the whole physical property seemed desirable as the best way to get an overall picture. Hence the first day's job was a casual, somewhat hurried inspection trip from the source, through production and distribution, to the cashier's pay window. My guide was Howard S. Morse, general manager, from whom the "flavor" of the administration was quickly discerned.

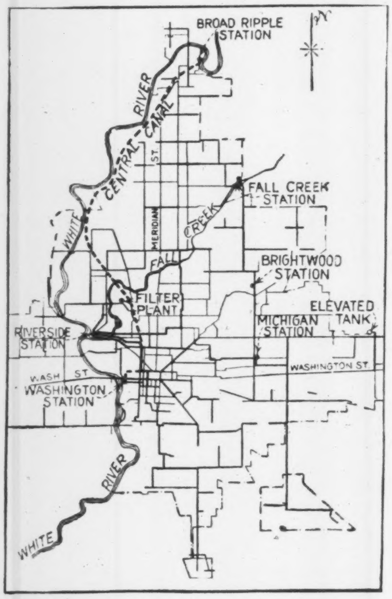


Fig. 1. Station locations and Water Distribution Feeders.

It seemed logical to inspect the whole property from the source on the White River at the Broad Ripple dam and the well field on Fall Creek down through town, following the 100-yr. old open canal which a predecessor of the present company bought from the state 87 yr. ago. This canal is used as a conduit to convey water 6.7 mi. from the dam down to the slow sand filters alongside which are rapid sand filters. After filtration this water finally reaches the Riverside pumping station and well field at the confluence of White River and Fall Creek.

A unit which I had never seen was the turbine station at the end of the canal where the 32 ft. of head gained in the canal is squeezed out through water turbines to pump filtered water at the ratio of 16 to 1. Some 14 m.g.d. is pumped directly into the heart of the distribution system through three 4-stage water-turbine-driven centrifugals 30 yr. old.

Other items of interest not heretofore visited were the meter shops and the garage for the fully motorized equipment. Here I met C. W. Winkle, superintendent of distribution, 45 years in service of the company, and his assistant, H. W. Niemeyer, a young Purdue graduate mechanical engineer, who has taken water meter maintenance and operation as a career (would that more waterworks staffs had young technically-trained men in their operating departments!).

The first stop on the inspection trip was the Fall Creek pumping station, location of a field of 15 wells, unused except in emergencies because the wells, which are 335 ft. deep and penetrate the limestone,

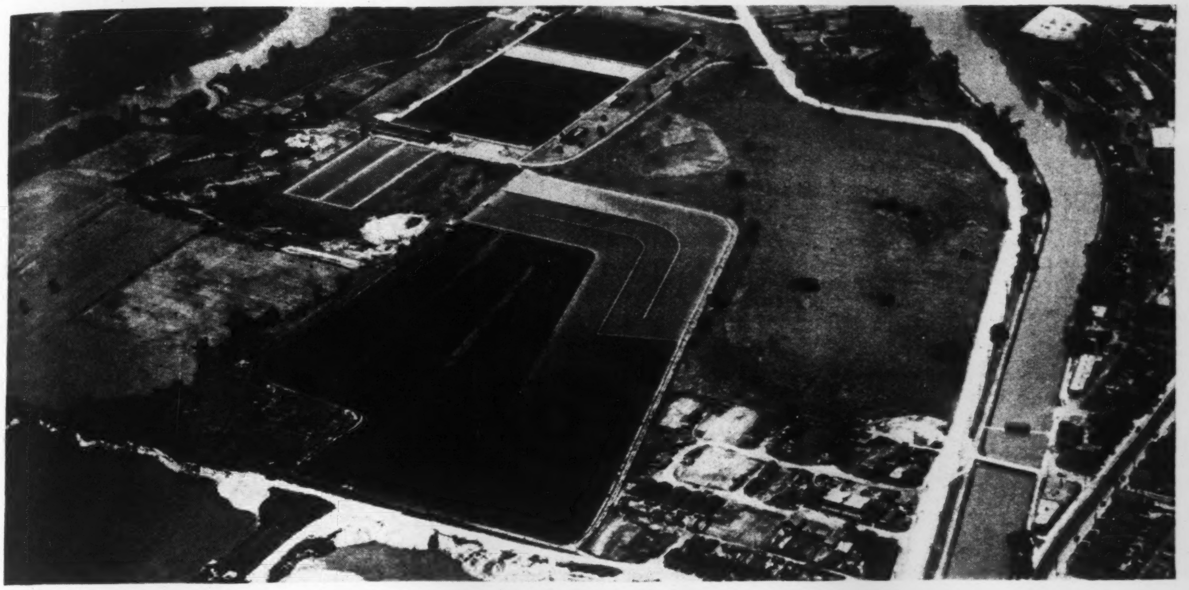


Fig. 2. **Rapid sand filters are located between the six slow sand filters (upper center) and the two coagulation basins. The large baffled basin showing turbid water (light color) at the entrance serves the slow sand plant. White River is at the left and the canal on the right.**

tap a source carrying more iron than the White River surface supply. Fall Creek drains a flat agricultural area of 315 sq. mi. and ultimately a 7-billion gallon impounding reservoir may be built 8½ mi. upstream. Incidentally, Indianapolis is one of the largest Middle West inland cities with decidedly limited water possibilities. Plans are all drawn for a rolled earth-fill dam 40 ft. high and 1,800 ft. long.

The first impression at the Fall Creek station was of a well-kept, neat property surrounded by carefully placed shrubbery and spacious lawns, dotted here and there with yellow sheet metal targets marking the location of valves and manholes.

Inside the new looking brick pumping station first to strike the eye and invoke comment was the brilliant yellow paint job on the pumping equipment, of which a steam cross-compound, of the vintage of 1915, was the most conspicuous. Why yellow? "Yellow and black, the latter for trim," said Mr. Morse, "are two of the five standard colors used by the company, reduced from twenty-six used a dozen years ago. Formerly a messy assortment of paint cans partly filled with different colors and types was to be found at each station." Why so many colors and kinds? Mr. Morse asked, without getting any satisfactory answer. Whereupon an investigation was started into this most controversial of topics. Later I met the chief chemist who had the fun of researching paints; he promised to tell the story in detail. Suffice now to say that light ivory, olive green, stone gray, yellow and black are the colors to survive. Each color has a definitely assigned place, and an order to paint does not require a higher-up decision on color or type. Yellow goes on hydrants and trucks for visibility and black goes with it for standard trim.

Standard practices

Time-consuming consideration of this topic of paint each time a new paint job comes up is thus eliminated but plenty of study has been given to it as well as to other recurring operations. Back in 1927 a standard practice manual was started. After two years Harry E. Jordan, then chemical engineer, who was given the responsibility of working up and editing such a manual, had prepared statements on a dozen practices, seven of which had gone the rounds and received approval of the department heads concerned.

Today a loose-leaf book, 2-in. thick, gives standard procedure for practically every repetitive item involved in company operation. The following is a representative list: Definitions, electrolysis, incoming mail, pressure divisions, accident reports, purchase of materials, holidays, flushing, construction and maintenance procedure, water main sterilization, vacations, hydrant setting, conditions of employment, paint, curb stops, stop-and-waste valves, length of meter service, charges for meter repairs, pumpage and production records.

A cabinet of novel electrical controls at Fall Creek intrigued my curiosity. It registers water levels in the Irvington elevated storage tank, 5 mi. away. The tank floats on the distribution system normally, with automatic shutoff when full and turn-on when the levels drop to 10 lb. less than tank-full. In case of fire or other emergency requiring high pressures the valves at the tank can be closed by manual remote controls. Three cardinal points for operators to observe in operating the tank are set down in the standard practice manual as follows: (1) Maintain a uniform rate of pumping throughout the 24 hr.; (2) have the tank full at 6 a.m.; (3) have a definite amount of withdrawal and storage each day.

As we proceeded to Broad Ripple and downtown, I learned that the 1½ and 6-m.g. reservoirs at Fall Creek station are fed from downtown plants and Fall Creek is in essence a booster plant with the 6-m.g.d. cross-compound augmented by 6 and 15-

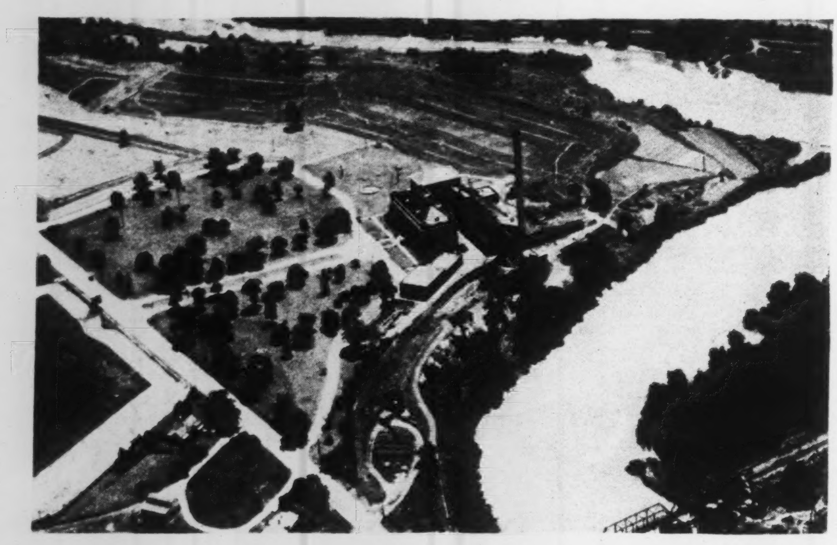


Fig. 3. Riverside pumping station and well field at the junction of the White River (right) and Fall Creek (top).

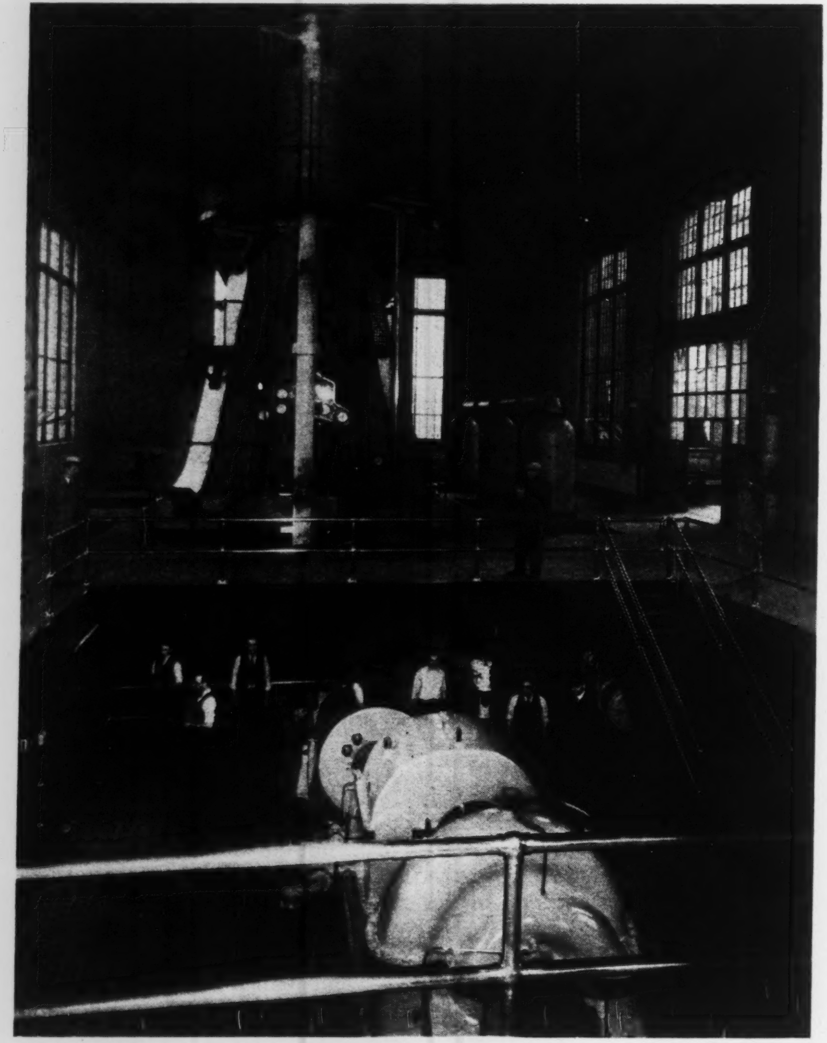


Fig. 4. The old and new; 30-m.g.d. crank-and-flywheel unit and 40-m.g.d. steam-turbine-driven centrifugal at Riverside

m.g.d. centrifugals driven by steam turbines. The wells at this point are for emergency and high-consumption periods. Here also is the location for a future filter plant to treat the water which will come down the creek bed from the proposed Oaklandon reservoir.

Broad Ripple dam is a low diversion structure on White River built 100 yr. ago. The canal which heads here is 6 ft. deep and 40 ft. wide at the bottom. It carries 200 m.g.d. Aside from furnishing the principal water supply it serves a few factories but mainly the condensers of the local power plant. The bridges over it, mostly skews, are maintained by the company if they are on roads that existed when the canal was built; otherwise the city or county is responsible. A concrete arch aqueduct over Fall Creek is a historic structure well preserved but needs attention in winter to be sure ice does not jam.

The canal long ago ceased to carry water craft. A substantial headgate structure of six 6x7-ft. sluicegates downstream from the intake to the filters was built 13 yr. ago, half at a time under operation within a narrow sheetpile cofferdam. The construction without mishap or interruption to flow of water to the turbines at the end of the canal was considered by W. C. Mabee, chief engineer, quite a feat. Regardless of flow—and in the last drought all of White River flow came down the canal—the canal is kept full to maintain a constant head in the settling basins of the purification plant.

Leaving the canal one enters the company's 124-acre tract over a new road along Fall Creek graded to form a levee 75 ft. wide on top. The company granted a right of way to the city for a river boulevard connection and WPA has been carrying out the improvement.

At the filter plant are six 35-yr. old slow sand filters of 36-m.g.d. capacity fed from a 45-m.g. settling basin. Alongside is a battery of six rapid filters built in 1925. Experiments with different underwater paints for the washwater troughs were under way, a local concern having developed a new formula "that looks good." Also work was about completed on a coagulant mixer, which will give an even higher percentage of efficiency than has heretofore been attained. C. K. Calvert, chemical engineer, and S. J. Tolman, sanitary engineer of the Jeffrey Manufacturing Co., jointly have worked for a year on the experiments, which consisted largely in finding the proper placement of baffles between the succession of stirring paddles.

Laboratory control of water has been practiced at Indianapolis as long as it has been available in this country. Records of analyses are on file that were made by the late Dr. E. G. Smith, water analyst of Beloit, Wis., and dated 1896. Dr. Smith that same year built the first water laboratory west of Chicago for the water company (now city-owned) at Denver, which like Indianapolis has a continuous record for the 42-year interval. When chlorine came along the waterworks officials of these cities were quick to adapt it to their requirements. Activated carbon is the latest aid to better water. It is not out of place to say that these early pioneer control laboratories and the men who have staffed them have contributed enormously to the art of modern water treatment. In their plants the gap between research and practice was bridged and the "bugs" taken out of the proposed processes, making them workable and adaptable to the plant in hand.

Perhaps a word might be said of the underground supplies. At the side of the filters in 1936 three 3-m.g.d. wells were put down into the gravel 74 ft. mainly for emergency use. Early in the history of the company a gallery system was installed at Riverside paralleling the river. This last year the gallery was filled up, thus terminating for Indianapolis a system considered quite the last word during the early period of intensive laboratory control.

The well field at the Riverside station comprises 253 acres and 40 wells driven an average of 325 ft. (from 160 to 419 ft.) into limestone. The 19 older ones are operated by airlift but all recent wells are equipped with motor-driven centrifugals, current coming from the local power company with emergency standby service from steam-turbine generator units in the station.

Riverside pumping station is the heart of the system. Here a 30-m.g.d. triple expansion pump and a 20-m.g.d. triple expansion pump still do duty every day although they are augmented by four steam-turbine centrifugals of 6, 8½, 30 and 40-m.g.d. capacity. T. C. Mauch, in charge of pumping equipment, had one of the turbines open for inspection. Little or no wear could be noted on the blades after several years use. Removal of a bit of sediment was the extent of the repair. After 30 years use two of the six 225-hp. boilers were removed to make way for two 512-hp. units. All are equipped with automatic stokers. Last year the ash-handling equipment was revamped to include a storage tank under which trucks may back to load.

The supply comes to the Riverside station from the wells and the two filter plants to suction wells at each end but connected in a ring around the station and so valved that either well may be utilized for full capacity with the other down.

A high-pressure and a low-pressure division of the distribution system is maintained with the latter showing 55 lb. on the gage in the company's office in the center of the city. No pressure increase is made for a first or "still" fire alarm. Riverside produces 75 lb. for the second alarm and 90 lb. for the third. Nearly every demand of the Underwriters is met in pressure and distribution system requirements for a Class 1 rating. Pressure recording gages are installed at fourteen places.

Distribution layout

In Fig. 1 is shown the well-gridironed distribution system of feeders, with pumping station and elevated tank locations. Mains are laid with 4½ ft. of cover in advance of improvements to roadways but after the contractor has excavated to grade. A definite standard practice is set down for inspectors and the construction department to follow.

Formerly a 12-oz. can of hypochlorite was shaken into every seventh length of new pipe. The line was to be filled slowly and allowed to stand 30 min., then flushed until no odor was observed. Recent examinations of jute and hemp used in the joints have indicated the desirability of sterilizing this material before use, and a search is being made for a satisfactory procedure.

Hydrants are set 250 ft. apart in the congested district and to cover 40,000 sq. ft. of area. This spacing is stepped up to 300 ft. and 60,000 sq. ft. in the manufacturing and minor merchandising districts; in residential areas to 350 ft. and 105,000 sq. ft. Location is such as to entail minimum future damage to hydrant, pedestrians and vehicles. Usually hydrants are placed 20 ft. from the curb line and back from intersections to minimize danger from traffic accident. If the property owner objects to the location the hydrant is moved farther away to a dividing line between lots.

Beginning in April each year a systematic schedule of flushing the system, which is combined with a test of hydrants for serviceability, is started. All dead ends, defined as a non-gridironed section of mains, 300 ft. long, get an additional flushing in October.

Merchandising methods

Left to the last is the topic of merchandising, since the company, like the electric utilities, is under the necessity of building up its consumption. Private wells are competitors. The company does plenty of advertising, some $20,000 worth per year with a publicity man, Miller Hamilton, in charge. He gets out all kinds of direct-to-consumer material and writes ads for the newspapers and for the five billboards which the company maintains. The manager made it clear that publicity is only a part of "public relations" for which the company maintains no department as such. Satisfactory relations with customers, he holds, depend on the product sold and the service rendered. Every person in the organization, whether he be telephone operator, contract clerk, cashier, meter reader, construction foreman or truck driver is an active unit in the effort to maintain good public relations. Advertising and other publicity is designed to stimulate active realization and appreciation of this service.

Probably the most effective, certainly the most striking form of publicity put out is the 800 ft. of colored movies which is the essence of some 4,000 ft. of shots. The movie has been shown to some 46,000 people in audiences averaging 110. An appropriation was under consideration during my visit for a sound movie.

The publicity department has plenty of worth-while educational material upon which to build its message to the consumer.

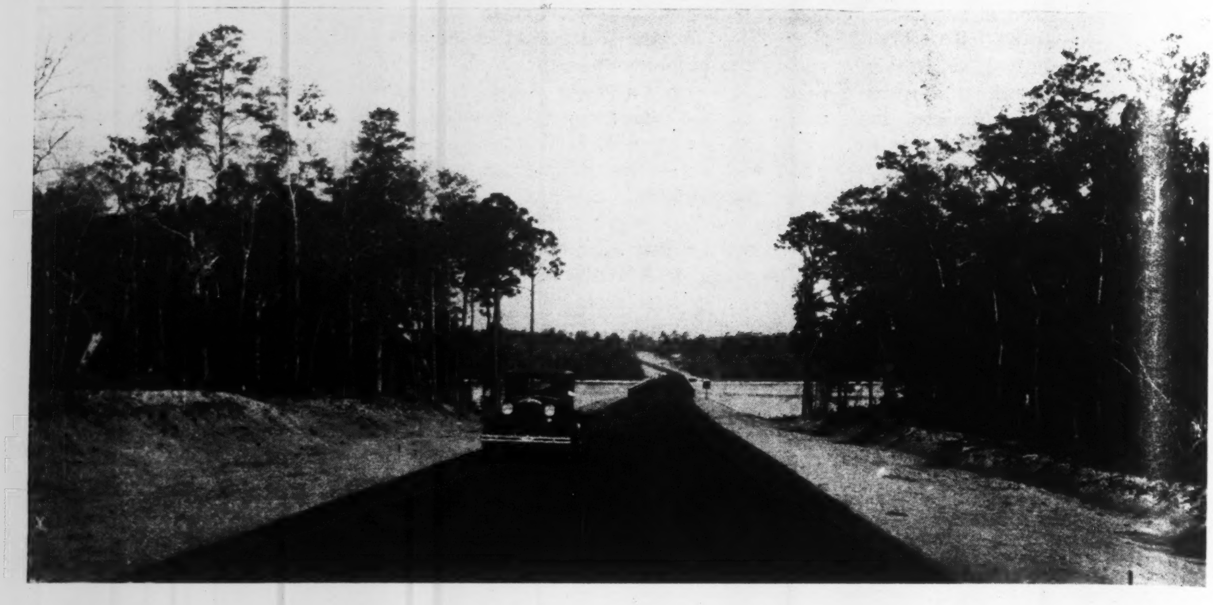


FIG. 1. FLORIDA BUILDS MILES OF SAND-BITUMINOUS BASE ON EASY GRADE AND ALINEMENT

Earth Roads in the South—II

C. S. Hill

Associate Editor, Engineering News-Record

Florida

In limerock, Florida has a unique road-base material that needs no processing and there is a wealth of shore sand that it has learned to process for earth roads that carry an immense tourist traffic

From Virginia the logical order of a survey of earth roadbuilding is through the Carolinas and actually these states were visited next but to present an immediate contrast to Virginia conditions North Carolina and South Carolina are skipped (to be returned to later) for an account of earth roads in Florida. These are quite distinctive.

In the first place Florida has a state road system and each of its counties has a network of county roads quite independent of state highway department administration. In general, state road practices govern in the type of road being considered; that is, the counties use the same local materials as the state and so far as road funds and usage warrant, use them in about the same way. As the state builds earth roads then is reasonably general practice, and it alone will be considered.

Good state for roads

The first impression from highway travel in Florida is that this state has a lot of road wealth. This does not mean that it has a lot of money for roads because, like most states in the South or for that matter in the North, East and West, it is short of funds to meet real road transport needs. Its wealth is in other things: in a climate that is easy on light road surfaces; in a topography that allows cheap and easy profile and line; in land conditions that make wide (200 ft.) rights-of-way possible; in wide-spread deposits of limerock that makes one of the finest of natural road bases; and in research-minded engineers that have learned the processing of forbidding sizes and gradations of coast sands into sound bases for highways.

Outstanding in interest to the roadbuilder is the limerock and sand-bituminous road-base construction. Florida is solving its low-cost road problem by surface treating a base of limerock or of sand processed on the road with asphalt or tar. All of its secondary type road construction is naturally not of these materials; shell, marl and even the harder limestones where they are found locally are used for base courses but limerock and sand-bituminous road mix take the lead and are given the most studious attention. These materials make excellent bases if covered with a waterproofing and wearing course. Generally this consists of a tar or an asphalt prime and one or two courses of asphalt with a cover of fine crushed stone or slag—the conventional bituminous surface treatment.

The limerock bases

Limerock is an old roadbuilding material in Florida practice. Before the days of state and federal engineering of roads it was hauled in by the local roadbuilders to cover and stabilize their soil roads. Engineering direction has refined its selection and processing and it is now used more widely and on more miles of state road than any other material. A year ago (*ENR*, July 29, 1937) in these columns, T. B. Massie of the Florida highway department gave a fine account of the native limerocks and of their use as bases for surface treatment. Little can be added here to this account except perhaps to note that with a better control of subgrade, thinner base courses are found to be adequate and of course they reduce the cost.

The construction of limerock base is simple, but careful control is wanted for the best results. The material is soft and easily crushed. Hauled to the grade it is spread, wetted and rolled in one or two layers depending on how thick it is laid. Roughly 6 in. is about as thick a base as it is well to lay in one course. Wetting is a real soaking; the material is saturated. After curing a few days the surface is lightly scarified, wetted, bladed to profile and rolled. A final curing period of a few days follows and then a final smoothing with a blade. The curing periods are important and call for good judgment of condition and time. A bituminous surface treatment completes the road; a well-smoothed limerock base gives an almost perfect riding surface but it wears easily and surface treatment is necessary both to take wear and to keep water out of the base.

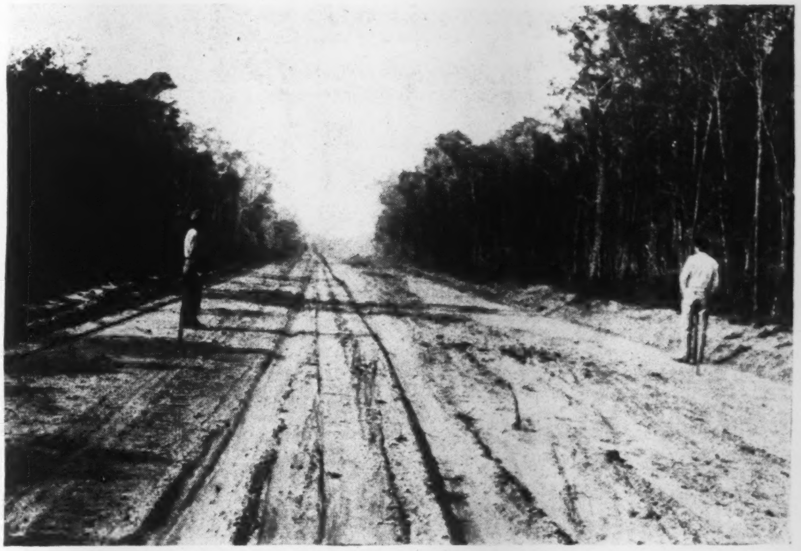


Fig. 2. **Florida coast sand as prepared for the first application of asphalt is just as loose and unstable as it looks here.**

Limerock is the most distinctive of Florida's native roadbuilding materials and limerock roads are an important part of the state highway system; there are some 4,000 mi., all 20 to 22 ft. wide, and Florida topography allows excellent alinement and profile.

Sand-asphalt bases

But limerock is not everywhere economically available in Florida. Along the Gulf coast particularly and well inland there is sand and little else than sand locally at the hand of the roadbuilder. The processing of this sand soil on the grade with asphalt to make stable road base is a development of which state highway engineers are proud. Indeed they are so possessed with this new development that they want to talk about it and do. One does not need to select among the road department engineers to find an enthusiast but he will get right at the fountain of belief by going to H. C. Weathers, division of tests, who has lived with the development, compiled a department bulletin on the subject, devised a soil test and worked out rules for field control. Only a little of what Mr. Weathers is prepared to tell can be given here.

Briefly the coast roadbuilders take

Fig. 3. **The first step in binding the sand is surface-wide pressure-distributor application of asphalt; look at ruts left by the distributor wheels.**

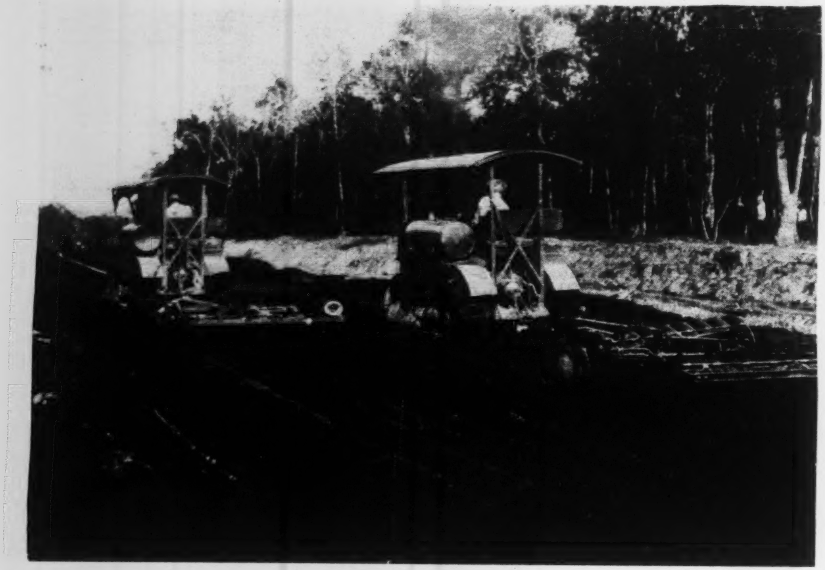


Fig. 4. Following the asphalt application, disc harrows mix the sand and binder over and over until the mix has a uniform color and texture.

a sand soil, and it is a real sand, such as is shown by Fig. 2 and sprinkle it with asphalt (Fig. 3). Then they mix sand and asphalt with disk harrows (Fig. 4) and blade the mixture back and forth across the road (Fig. 5) and then roll it firm (Fig. 6) to produce the finished road shown by Fig. 1. This is only the process in general; the details are the vital thing.

Accuracy of processing is the distinctive characteristic. Sand-bituminous mixes are not new in roadbuilding; the characteristic of Florida practice is the control by test, first of the suitability of the natural soil, then of the volume of bituminous material and then the processing of the soil by degrees or in fractional parts by road-mix methods. Machine mix on the grade has been used and its development is looked forward to, but road mix is the common practice and is the practice discussed for the moment.

Soil Stability Tests—Naturally the road sands found vary in gradation, particle size and shape and in the content of clay, loam and silt. Some of them when processed do not stand up, particularly under static load, but shift and flow. Investigation has shown that this is generally due to the gradation and shape of the soil particles. A soil survey and test program is therefore the initial procedure in sand-bituminous-mix base construction.

The Florida engineers proceed rather thoroughly. Samples are taken to a depth of 8 or 10 in. of the road surface soil at every 500 ft. along the road or wherever a change in soil quality or gradation is observed. In the laboratory sieve analyses are made, percentages of silica, silt, clay, loam and foreign matter are determined and a stability or bearing test is conducted. The stability test is relied on chiefly. As a rule loam and silt do not injure the quality of the material; in fact they generally supply the fines that aid stability. A considerable excess of foreign matter is of course bad and should be removed. A clay content exceeding 10 per cent commonly gives trouble by balling up in the mix; a material containing over 10 per cent may generally be regarded as unfit.

Sieve analyses are made more as a record than for any use made of them in correcting gradation. Reliance for soil modification is placed on the stability test and because it is so crucial some detail of the device and method of making the test is warranted. Fig. 7 shows the testing machine. It is simple. A lever operated by a shot-bucket presses a bearing plug, with a face of 1 sq.in., onto the surface of a soil sample held in a cylindrical container 3 in. in diameter and 3 in. high.

The soil is dried to constant weight and 500 c.c. are mixed with 10½ c.c. of water. The container is filled and a bearing plate just fitting inside is pressed down by hand and removed. More material is added and coned up above the top and again pressed down with the bearing plate. The surplus material is scraped off flush with the container top and the bearing plate is replaced and given a pressure of 1,200 lb. The bearing plug is then set in contact with the surface of the sample and loaded until failure of the soil occurs.

What precisely are the safe bearing values as determined by the test described is not very definite. It is known, however, that materials from

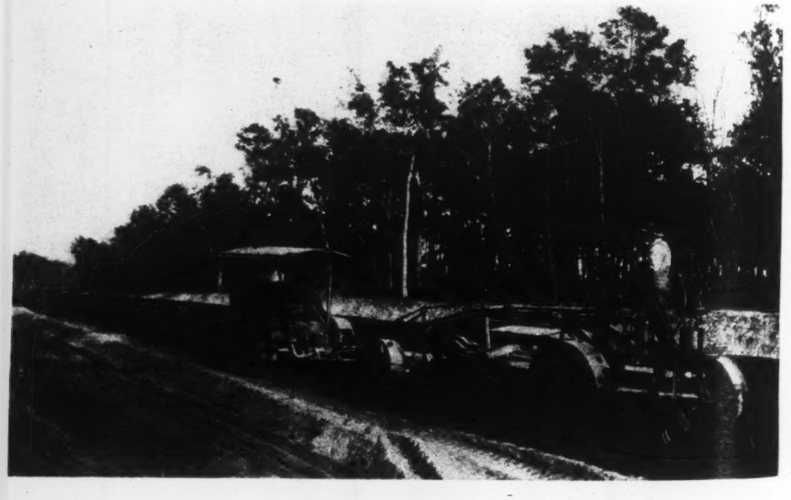


Fig. 5. And then blade graders windrow the mix to the sides and back again in fractions as increments of asphalt are applied.

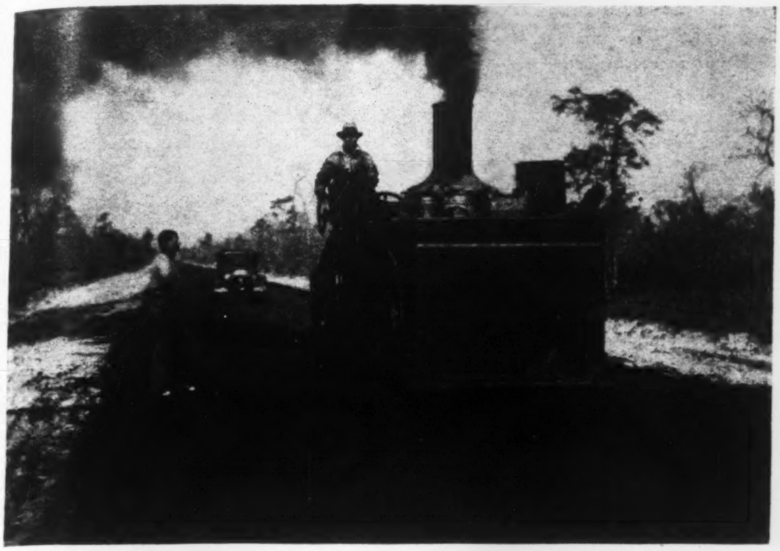


Fig. 6. A modern roller compacts the sand-bituminous mix and puts the finishing touches on a smooth travel way.

roads that have stood up have shown a bearing value of 25 lb. per sq.in. and this has been arbitrarily adopted as a measure of stability and is being used in current construction. Any material showing less value is conditioned by blending other material with it.

Volume of Bitumen — As in all bituminous mixes the volume of bituminous material required varies with the kind of the bituminous material and the nature of the aggregate in respect to gradation, fineness, particle shape, nature of particle surface, etc. So far Florida experience has not indicated any formula for volume but a trial procedure has been worked out. Sample mixes are worked up in the laboratory and from the results the field engineer is furnished with an estimate of volume. On work compacted the volume has ranged from 3½ to 7 gal. per sq.yd. of 6-in. completed base.

The bituminous materials used have been coal tar, petroleum tar and cutback asphalt, the last most commonly. Some variation in cutback material has been found desirable but for the majority of soils it is recommended that a base asphalt of 85 to 100 penetration be used.

Stage Processing—After the stability of the sand is controlled, construction proceeds in about the conventional manner of road-mix work but with particular attention to fractional processing. About 3,000 ft. are worked on at one time.

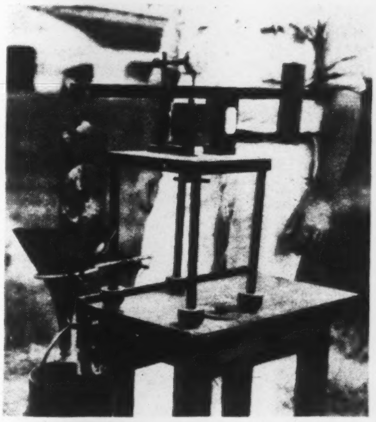


Fig. 7. Stability of the sand soil is measured by a plunger test machine.

The road surface is plowed to about 2 in. below the proposed depth of base and cleaned of roots. The plowed width is about 1 ft. greater, 6 in. on each side, than the proposed base width. The top 3 or 4 in. is processed first by applying 1½ gal. of the cutback or tar in successive fractions of 0.35 gal. per sq.yd. and mixing each application with a disk harrow. The mixed top is bladed to both sides and windrowed clear of the base width and the bottom half of the plowed material is treated and mixed like the top in successive 0.35-gal. applications until a well-bonded but not a rich mix is obtained. This is then bladed to surface and profile.

The windrowed top mix is then bladed back in three installments, each being given a 0.35-gal. treatment and mixed with harrows, great care being taken not to leave sand streaks between layers. The edges and quarters are then plowed to full depth and the plowed material is given successive applications of from 0.15 to 0.2 gal. continuously mixed in with blade and harrow. This gradual application brings the mix to the desired consistency without danger of flooding. When mixed, the base is bladed to profile and a skin cut made to firm material. The surface is finally rolled with a 5-ton tandem roller to a smoothness of ½ in. in 10 ft. and the edges are trimmed to line.

Experience Record — Sand-bituminous bases are considered a success in Florida. No conviction is held that they are a solution regardless of location, available materials and volume of travel. They do have merit and utility, it is felt, in locations, as in sections of Florida, where the existing road material is predominantly sand, where a warm dry construction season is usual, where the traffic is of medium volume and where the drainage is good.

There are about 350 mi. of these roads in Florida, some of which are about eight years old. The cost has ranged from 40 to 90c. a square yard. Usually the base as built is not surfaced until after a few years when it begins to wear and oxidize and then it is given a surface treatment.

Design not surface deep

Florida does not stop with surfaces in engineering its earth roads. Mention has been made of the wide right-of-way and of the topography that makes it easy to keep to high standards of line and profile. High-type roadway design is particularly noticeable in all recent surfacing of the kind described. Stress is put on flattening cross-profile slopes, drainage is carefully designed and fills are built in layers. In muck land the limits of muck excavation and removal have been increased as a greater precaution against roadbed settlement under traffic. In all instances where possible it is practice to remove from under the roadbed area the full depth of existing muck. This operation is facilitated by the use of dragline machines with long booms and the acquisition of wider rights-of-way on which to store the unsuitable material.

Highway direction

Florida state highways are under a commission management with J. H. Dowling as state highway engineer. The writer is indebted to him, to T. B. Massie, engineer roadside improvements and to H. C. Weathers for information and visual inspection of sand-bituminous and limerock roads.

Next week Alabama stabilized soil bases and bituminous surface treatment methods present material for an article on one of the most interesting developments in earth road work in the South.

FROM FIELD AND OFFICE

Working problems and time-saving methods . . . Edited by Charles S. Hill

Decanting Muddy Lake Water

M. K. Millard

Planning and Development Engineer,
Bureau of Agricultural Economics,
Clemson, S. C.

In 1937 the Department of Agriculture completed a concrete gravity dam on Six Mile Creek. This dam impounds a lake of 135 acres. The lake bed is unusually deep for lakes in this section, a fact which has aided in solving one of the most perplexing problems connected with the maintenance of the clarity of the water, which is impounded exclusively for recreational purposes but which is subject to a large flow of muddy water during each heavy rain.

It was noticed, by observing the flow from a small cloudburst, during the latter part of May, that the clay-burdened water flowing into the impounded waters dropped perceptibly to a lower level leaving the clear water on the surface and taking considerable time to muddy even the upper delta area.

Taking a cue from the above observation, the gates opening the bleeder pipes were raised. These two 30-in. pipes are 40 ft. below the crest of the spillway and in line with the old stream channel. Immediately the flow through the bleeder pipes became muddy and the gates were regulated to control the outflow so as not to lower the lake surface below the spillway crest.

Using the data obtained it has been found possible to maintain a clear body of water under all but one condition. That condition exists when heavy rains persist over a long period and are accompanied by high winds. The wind stirs the surface creating disturbing currents.

• • •

To Find the Radius of an Arch

When the span and rise of a segmental arch are given the radius can be found as follows:—Daniel Griffith, Pittsburgh, Pa.

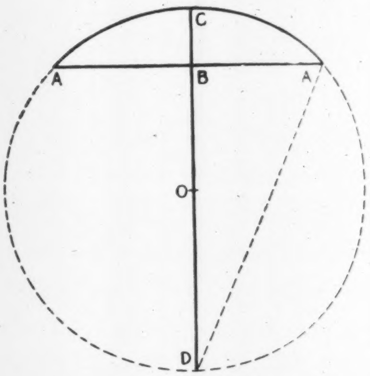
$$CB : AB :: AB : BD$$

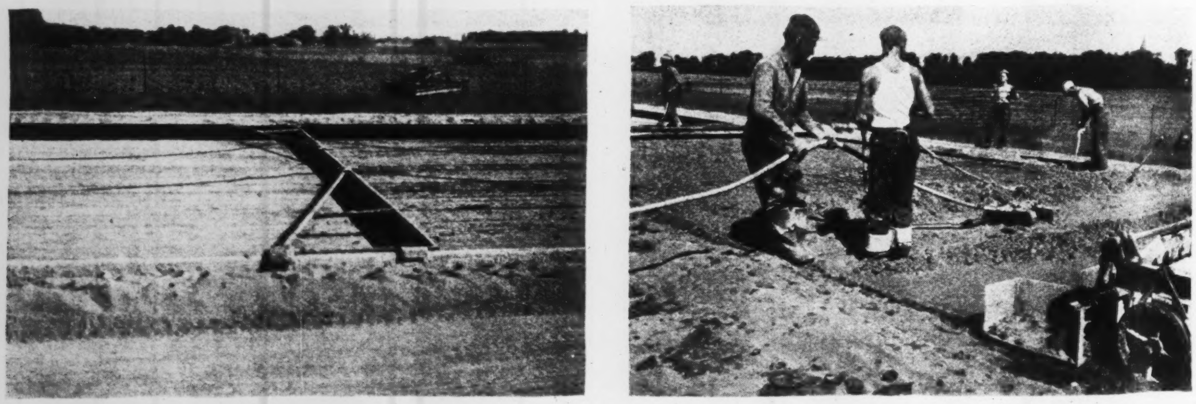
$$\text{Then } \frac{AB \times AB}{CB} = BD$$

$$\frac{BD + CB}{2} = \text{Radius}$$

$$\text{where } AA = \text{span } AB = \frac{AA}{2}$$

$$CB = \text{rise of arch.}$$





HELPS TO BETTER PAVEMENTS JOINTS

On recent concrete road operations the contractors were helping out the fussy operation of installing expansion joints by the devices illustrated.

1. To hold the premolded joint filler from bending out of line when the concrete is poured against it, it is braced from side forms by pipes.

2. Dense concrete at the parting strip of joint filler is secured by a small surface vibrator worked back and forth over the line of the joint.